ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

(MEDICAL ENGINEERING)

Curriculum and Syllabus

4-year B Tech Program @ School of Artificial Intelligence

2024

B.Tech. Artificial Intelligence & Data Science (Medical Engineering)

A 4-year professional degree conceived and designed for those who aspire to work with computers, computational modelling and artificial intelligence, for solving real-world problems in medicine.

Program Vision Statements: 1. Training engineers who can work with physicians to provide more affordable healthcare to public, significantly reducing the cost of educating professionals. 2. Helping the conventional medical pedagogy to transit to AI technology-integrated biomedical education.

Mission Protocol: At Amrita, we believe in inculcating values founding a culture of the heart. **Fundamentals, specifics and practices of AIME inculcated with both real and virtual "hands-on" approach, facilitating experimental, experiential and conceptual understanding.*

**Continuous and periodical assessment (using thin clients and servers) with mini-projects, practicals, assignments, spot-tests, and announced quizzes. (Descriptive evaluations shall be discouraged and higher-order-thinking and team-spirit methods encouraged.)*

**Teaching-learning and assessment processes would have extensive experimental modalities (although not mentioned specifically), including programming and AR/VR components.*

**All Micro-credential courses are of 8 hours' contact class duration followed by a test and assignment/mini-project (and subject to change based on demands).*

Curriculum: The first five semesters will concentrate on building up the students' foundations in core subjects such as Programming/Coding/Maths in AI, Biochemistry/Physiology in Biomedical fields, etc. In the remaining semesters, students will receive in-depth training in advanced subjects and electives, in addition to project-based learning. Besides this, one micro-credential course per month would be a routine feature through all semesters. There would be add-on and bridge courses, workshops/symposia, etc. for those that desire the same. The contents of the program are in line with the mandates of the National Educational Policy (stressing on the mandate to nurture interdisciplinary curriculum). The Chairman (at the advice of the faculty) could introduce contents into the syllabus based on trendy and cutting-edge developments in the field, to keep the program competitive.

Who is a typical student for the program: (a) If you like mathematics and computers, and want to work in the bio/medicine/health sector**.** (b) If you want to be part of the growing AI revolution in healthcare, and impact societal progression.

PROGRAM SPECIFIC OBJECTIVES/OUTCOMES (PSO): Graduates of this program should be able to:

PSO1: Develop an in-depth understanding of the principles, mathematical concepts, tools and algorithms of AI applied to metabolic, physiological and allied biological problems in Medicine and Healthcare.

PSO2: Apply AI principles in healthcare data research and analysis, and communicate their findings to the medical community.

PSO3: Use AI to design innovative solutions for making informed decisions based on data-driven insights, identify and execute projects applying AI and clinical data to tailor medical treatment and healthcare decisions to the individual requirement of each patient.

Engineering PROGRAM OUTCOMES

Engineering Graduates are expected to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

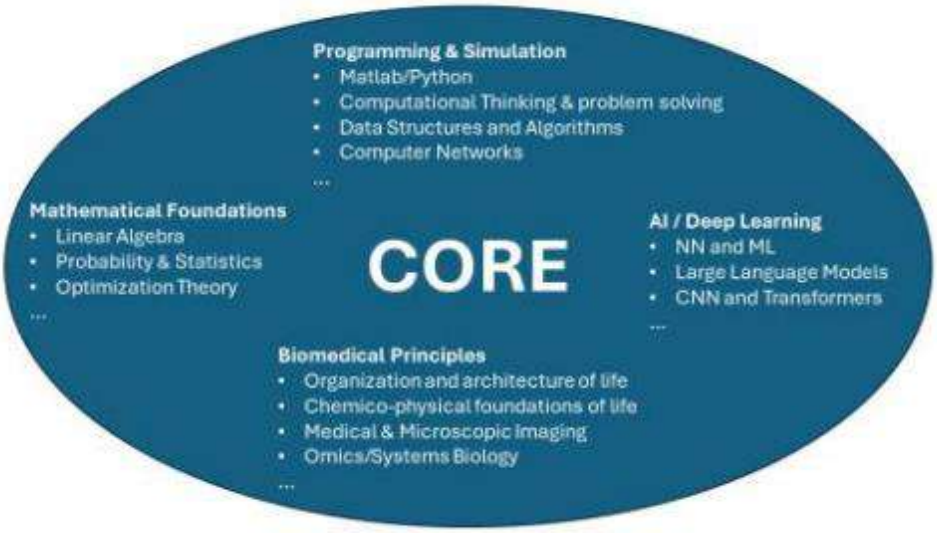
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



Overview of curriculum

YEAR	Sem	Engg	Core	Elec	Sc	*H-M*	Proj	OpE	M		Credits	Remarks
I	***1***	3	7	0	7	3	0	2	0		22	
I	***2***	3	10	0	6	1	0	2	0		22	
II	***3***	3	10	0	6	2	0	0	0		21	
II	***4***	3	10	0	6	2	0	2	0		23	
III	***5***	3	13	0	3	2	0	2	0		23	
III	***6***	0	7	12	0	0	0	2	0		21	
IV	***7***	0	0	15	0	0	2	0	0		17	
IV	***8***	0	0	0	0	0	13	0	0		13	
Tot (Amrita)		15	57	27	28	10	15	10	0		162	
Tot (AICTE)		18	48	18	25	12	15	18	0		160	

Teaching & Assessment: *Continuous and periodical assessment (using thin clients and servers) with mini-projects/practicals/assignments/spot-tests/announced quizzes. Descriptive evaluations shall be discouraged and higher-order-thinking and hands-on methods encouraged. All teaching-learning and assessment processes may/would have experimental modalities (although not mentioned specifically), including programming and AR/VR components. Similarly, although the syllabus/CO of any course need not specifically mention AI/Programming components, their inculcation in teaching/evaluation exercises are implied. All micro-credential (fractal) courses are of 8 hours' contact class duration followed by a test and assignment/mini-project (and subject to change based on demands).*

Year I, 1st Semester

S No.	Course	Title	Credits	Weekly
1	23MAT106	Mathematics for Intelligent Systems 1	4	3-0-2
2	24AIM101	Computational thinking, programming & problem solving	3	2-0-2
3	24AIM102	Introduction to cell biology, biochemistry & anatomy	3	2-0-2
4	24AIM103	Research Methodology and Communication for AIME	2	1-0-2
5	24EEE101	Foundations in Electrical and Electronic Engg.	3	2-0-2
6	22AVP103	Mastery Over Mind	2	1-0-2
7	22AVP212	Amrita Value Program I (Introduction to Traditional Indian Systems of Medicine)	1	1-0-0
8		Micro-credential Courses- set 1	4	3-0-2
		Total	**[22]**	**[29 hrs.]**

Year I, 2nd Semester

S No.	Course	Title	Credits	Weekly
1	23MAT112	Mathematics for Intelligent Systems 2	3	2-0-2
2	24AIM111	Introduction to data structures & algorithms	3	2-0-2
3	24AIM112	Molecular biology & basic cellular physiology	3	2-0-2
4	24AIM113	Introduction to NN, CNN and GNN	3	2-0-2
5	24AIM114	Analog system design	3	2-0-2
6	24AIM115	Ethics, innovative research, businesses & IPR	2	1-0-2
7	22AVP208	Amrita Value Programme II (Insights into Indian Arts and Literature)	1	1 0 0
8		Micro-credential Courses- set 2	4	3-0-2
		Total	**[22]**	**[29 hrs.]**

Year II, 3rd Semester

S No.	Course	Title	Credits	Weekly
1	23MAT204	Mathematics for Intelligent Systems 3	3	2-0-2
2	24AIM201	Mechanics & fluidized systems	3	2-0-2
3	24AIM202	Macroscopic and systemic physiology	3	2-0-2
4	24AIM203	Introduction to NLP, Transformers & LLM	3	2-0-2
5	24AIM204	Foundations of computer architecture	3	2-0-2
6	22ADM101	Foundations of Indian heritage	2	2-0-1
7	23LSE201	Life skills for Engineers I	P/F	1-0-2
8		Micro-credential Courses -set 3	4	3-0-2
		Total	**[21]**	**[31 hrs.]**

Year II, 4th Semester

S No.	Course	Title	Credits	Weekly
1	23MAT214	Mathematics for Intelligent Systems 4	3	2-0-2
2	24AIM211	Machine learning for cheminformatics & bioinformatics	3	2-0-2
3	24AIM212	Foundations of pathology & pharmacology	3	2-0-2
4	24AIM213	Introduction to biomaterials & engineering	3	2-0-2
5	24AIM214	Computer operating systems & networks	3	2-0-2
6	23CUL232	Free Electives (Exploring science and technology in ancient India)	2	2-0-0
7	22ADM111	Glimpses of Glorious India	2	2-0-1
8	23LSE211	Life skills for Engineers II	2	1-0-2

9		Micro-credential Courses -set 4	4	3-0-2
		Total	**[25]**	**[33 hrs.]**

Year III, 5th Semester

No.	Course	Title	Credits	Weekly
1	24AIM301	Signal & image processing	3	2-0-2
2	24AIM302	Biomedical data acquisition & management	3	2-0-2
3	24AIM303	Biological systems, simulation and modeling	3	2-0-2
4	24AIM304	Reinforcement learning	3	2-0-2
5	24AIM305	Introduction to DBMS	3	2-0-2
6	23HUM233	Free Electives (Glimpses of Indian economy and polity)	2	2-0-0
7	23LSE301	Life skills for Engineers III	2	1-0-2
8		Micro-credential Courses -set 5	4	3-0-2
		Total	**[23]**	**[30 hrs.]**

Year III, 6th Semester

No.	Course	Title	Credits	Weekly
1	24AIM311	Biostatistics	3	2-0-2
2		Elective 1	3	2-0-2
3		Elective 2	3	2-0-2
4		Elective 3	3	2-0-2
5		Elective 4	3	2-0-2
6	23LSE311	Life skills for Engineers IV	2	1-0-2
7		Micro-credential Courses -set 6	4	3-0-2
		Total	**[21]**	**[28 hrs.]**

Year IV, 7th Semester

No.	Course	Title	Credits	Weekly
1.		Elective 5	3	2-0-2
2.		Elective 6	3	2-0-2
3.		Elective 7	3	2-0-2
4.		Elective 8	3	2-0-2
5.		Elective 9	3	2-0-2
6.	24AIM498	Project Phase I	2	
		Total	**[17]**	[20 hrs.]

Year IV, 8th Semester

No.	Course	Title	Credits	Weekly
1.	24AIM499	Project Phase II	13	
		Total	**[13]**	[Nil]

Micro-credential courses

Semester 1, Micro-credential courses Set 1

24AIM131	Introduction to ML –Decision tree, Clustering, Regression
24AIM132	WEKA tool for ML
24AIM133	Chemical Molecular representation for AI -Matrices, SMILES, SELFIES
24AIM134	Use of AR and VR in medicine

Semester 2, Micro-credential courses Set 2

24AIM141	Patterns in Software Design (Model -view-controller, Command, Observer Patterns)
24AIM142	Introduction to Linux operating system and Commands
24AIM143	Introduction to Internet and Protocols
24AIM144	Introduction to Data Compression

Semester 3, Micro-credential courses Set 3

24AIM231	Signal Processing with LA and Optimization and Probability theory
24AIM232	Introduction to Signal Acquisition systems, ECG, EEG
24AIM233	Brain-computer interface devices
24AIM234	Introduction to Biomechanics

Semester 4, Micro-credential courses Set 4

24AIM241	Introduction to Programming on FPGAs
24AIM242	Introduction to web programming
24AIM243	Introduction to Interfacing Devices to Computers (standards and Protocols)
24AIM244	Advanced programming with FPGAs

Semester 5, Micro-credential courses Set 5

24AIM331	Low field MRI construction
24AIM332	Introduction to Cloud Computing
24AIM333	Introduction to Full stack software development
24AIM334	Making ultra sound stethoscope: Principle, construction and analysis of data

Semester 6, Micro-credential courses Set 6

24AIM341	SVD and ADMM revisited
24AIM342	Distributions derived from Normal distributions and Statistical Inference
24AIM343	Spatio-temporal Data Analytics with VMD and DMD
24AIM344	Vector Databases

No.	Semester	Course Code	Course Title
1	6th	24AIM431	Biomedical instrumentation
2	6th	24AIM432	Cell culture and tissue engineering
3	6th	24AIM433	Emerging areas in biomedical engineering
4	6th	24AIM434	Bio photonics
5	6th	24AIM435	Lab-on-chip devices
6	6th	24AIM436	AI in emergency, forensic and molecular medicine
7	6th	24AIM437	Advanced biomechanics
8	6th	24AIM438	Artificial organs
9	6th	24AIM439	Advanced bioinformatics
10	7th	24AIM440	BioMEMS
11	7th	24AIM441	Drug delivery systems
12	7th	24AIM442	3D printing in biomedicine
13	7th	24AIM443	Embedded and real time systems
14	7th	24AIM444	Healthcare management
15	7th	24AIM445	Telemedicine
16	7th	24AIM446	Basic clinical science
17	7th	24AIM447	Medical Microbiology & Immunology
18	7th	24AIM448	Nano, novel & alternative medicine approaches

Aligned Elective Courses

Special Electives

No.	Course Code		Credits	Weekly	Remarks
		CSE-Electives			
1	24CSE431	Advanced Database Management Systems	3	2-0-2	
2	24CSE432	Computer Graphics	3	2-0-2	
3	24CSE433	Distributed Computational Systems	3	2-0-2	
		Robotics-Electives			
1	24RAI431	Sensors & actuators for robotics	3	2-0-2	
2	24RAI432	Under actuated robots	3	2-0-2	
3	24RAI433	Multi Robot Systems	3	2-0-2	
4	24RAI434	Robotic Operating Systems & Robot Simulation	3	2-0-2	
		ECE-Electives			
1	24ECE431	Radio Frequency Communication Systems	3	2-0-2	
2	24ECE432	Analog Circuits	3	2-0-2	
3	24ECE433	Signals and Control Systems	3	2-0-2	
4	24ECE434	Digital and VLSI Systems	3	2-0-2	

Course evaluation pattern:

Assessment	Internal/External	Weightage (%)
Assignments (minimum 3)	Internal	30
Quizzes (minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

Courses offered under the framework of Amrita Values Programmes I and II

Table 3 New names for Amrita Value Programmes for UG programmes			
Course Code	**Title**	**L-T-P**	**Credits**
22ADM201	Strategic Lessons from Mahabharatha	1-0-0	1
22ADM211	Leadership from Ramayana	1-0-0	1
22AVP210	Kerala Mural Art and Painting	1-0-0	1
22AVP201	Amma's Life and Message to the modern world	1-0-0	1
22AVP204	Lessons from the Upanishads	1-0-0	1
22AVP205	Message of the Bhagavad Gita	1-0-0	1
22AVP206	Life and Message of Swami Vivekananda	1-0-0	1
22AVP207	Life and Teachings of Spiritual Masters of India	1-0-0	1
22AVP208	Insights into Indian Arts and Literature	1-0-0	1
22AVP213	Traditional Fine Arts of India	1-0-0	1
22AVP214	Principles of Worship in India	1-0-0	1
22AVP215	Temple Mural Arts in Kerala	1-0-0	1
22AVP218	Insights into Indian Classical Music	1-0-0	1
22AVP219	Insights into Traditional Indian Painting	1-0-0	1
22AVP220	Insights into Indian Classical Dance	1-0-0	1
22AVP221	Indian Martial Arts and Self Defense	1-0-0	1
22AVP209	Yoga and Meditation	1-0-0	1

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY				
Cat.	**Course code**	**Title**	**L T P**	**Credit**
SCI	**23CHY240**	**Computational Chemistry and Molecular Modelling**	**3 0 0**	**3**
SCI	**23CHY241**	**Electrochemical Energy Systems and Processes**	**3 0 0**	**3**
SCI	**23CHY242**	**Fuels and Combustion**	**3 0 0**	**3**
SCI	**23CHY243**	**Green Chemistry and Technology**	**3 0 0**	**3**
SCI	**23CHY244**	**Instrumental Methods of Analysis**	**3 0 0**	**3**
SCI	**23CHY245**	**Batteries and Fuel Cells**	**3 0 0**	**3**
SCI	**23CHY246**	**Corrosion Science**	**3 0 0**	**3**
PHYSICS				
SCI	**23PHY240**	**Advanced Classical Dynamics**	**3 0 0**	**3**
SCI	**23PHY241**	**Electrical Engineering Materials**	**3 0 0**	**3**
SCI	**23PHY242**	**Physics of Lasers and Applications**	**3 0 0**	**3**
SCI	**23PHY243**	**Concepts of Nanophysics and Nanotechnology**	**3 0 0**	**3**
SCI	**23PHY244**	**Physics of Semiconductor Devices**	**3 0 0**	**3**
SCI	**23PHY245**	**Astrophysics**	**3 0 0**	**3**
MATHEMATICS				
SCI	**23MAT240**	**Statistical Inference**	**3 0 0**	**3**
SCI	**23MAT241**	**Introduction to Game Theory**	**3 0 0**	**3**
SCI	**23MAT242**	**Numerical Methods and Optimization**	**3 0 0**	**3**

FREE ELECTIVES

FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAM				
Cat.	Course Code	Title	L T P	Credit
HUM	23MNG331	Financial Management	3 0 0	3
HUM	23MNG332	Supply Chain Management	3 0 0	3
HUM	23MNG333	Marketing Management	3 0 0	3
HUM	23MNG334	Project Management	3 0 0	3
HUM	23MNG335	Enterprise Management	3 0 0	3
HUM	23MNG336	Operations Research	3 0 0	3
HUM	23MEE321	Industrial Engineering	3 0 0	3
HUM	23MEE322	Managerial Statistics	3 0 0	3
HUM	23MEE323	Total Quality Management	3 0 0	3
HUM	23MEE324	Lean Manufacturing	3 0 0	3
HUM	23CSE321	Software Project Management	3 0 0	3
HUM	23CSE322	Financial Engineering	3 0 0	3
HUM	23CSE323	Engineering Economic Analysis	3 0 0	3
HUM	23CSE324	Information Systems	3 0 0	3

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS				
Cat.	Course Code	Title	L T P	Credit
HUM	23CUL230	Achieving Excellence in Life - An Indian Perspective	2 0 0	2
HUM	23CUL231	Excellence in Daily Life	2 0 0	2
HUM	23CUL232	Exploring Science and Technology in Ancient India	2 0 0	2
HUM	23CUL233	Yoga Psychology	2 0 0	2
HUM	23ENG230	Business Communication	1 0 3	2
HUM	23ENG231	Indian Thought through English	2 0 0	2
HUM	23ENG232	Insights into Life through English Literature	2 0 0	2
HUM	23ENG233	Technical Communication	2 0 0	2
HUM	23ENG234	Indian Short Stories in English	2 0 0	2
HUM	23FRE230	Proficiency in French Language (Lower)	2 0 0	2
HUM	23FRE231	Proficiency in French Language (Higher)	2 0 0	2
HUM	23GER230	German for Beginners I	2 0 0	2
HUM	23GER231	German for Beginners II	2 0 0	2
HUM	23GER232	Proficiency in German Language (Lower)	2 0 0	2
HUM	23GER233	Proficiency in German Language (Higher)	2 0 0	2
HUM	23HIN230	Hindi I	2 0 0	2
HUM	23HIN231	Hindi II	2 0 0	2
HUM	23HUM230	Emotional Intelligence	2 0 0	2
HUM	23HUM231	Glimpses into the Indian Mind - the Growth of Modern India	2 0 0	2
HUM	23HUM232	Glimpses of Eternal India	2 0 0	2
HUM	23HUM233	Glimpses of Indian Economy and Polity	2 0 0	2
HUM	23HUM234	Health and Lifestyle	2 0 0	2
HUM	23HUM235	Indian Classics for the Twenty-first Century	2 0 0	2
HUM	23HUM236	Introduction to India Studies	2 0 0	2
HUM	23HUM237	Introduction to Sanskrit Language and Literature	2 0 0	2
HUM	23HUM238	National Service Scheme	2 0 0	2
HUM	23HUM239	Psychology for Effective Living	2 0 0	2
HUM	23HUM240	Psychology for Engineers	2 0 0	2
HUM	23HUM241	Science and Society - An Indian Perspective	2 0 0	2
HUM	23HUM242	The Message of Bhagwat Gita	2 0 0	2

HUM	23HUM243	The Message of the Upanishads	2 0 0	2
HUM	23HUM244	Understanding Science of Food and Nutrition	2 0 0	2
HUM	23HUM245	Service Learning	2 0 0	2
HUM	23JAP230	Proficiency in Japanese Language (Lower)	2 0 0	2
HUM	23JAP231	Proficiency in Japanese Language (Higher)	2 0 0	2
HUM	23KAN230	Kannada I	2 0 0	2
HUM	23KAN231	Kannada II	2 0 0	2
HUM	23MAL230	Malayalam I	2 0 0	2
HUM	23MAL231	Malayalam II	2 0 0	2
HUM	23SAN230	Sanskrit I	2 0 0	2
HUM	23SAN231	Sanskrit II	2 0 0	2
HUM	23SWK230	Corporate Social Responsibility	2 0 0	2
HUM	23SWK231	Workplace Mental Health	2 0 0	2
HUM	23TAM230	Tamil I	2 0 0	2
HUM	23TAM231	TAMIL II	2 0 0	2

Semester I

23MAT106	Mathematics for Intelligent Systems 1	Cr 4	3-0-2

Course Objectives

- To introduce students to the fundamental concepts and techniques of linear algebra, ordinary differential equations, probability theory, complex numbers, and quantum computing that are necessary for further study in science and related fields.
- To enable students to apply the concepts they learn in practical situations by using analytical and numerical methods to model real-world problems.
- To expose students to the wide range of applications of linear algebra, ordinary differential equations, probability theory, complex numbers, and quantum computing within the scientific field and to inspire them to pursue further study or research in these areas.
- To introduce students to the fundamental concepts of quantum computing
- To develop students' ability to communicate mathematical concepts and solutions clearly and effectively.

Course Outcomes:

After completing this course, students should be able to

CO1: Apply the fundamental concepts of linear algebra and calculus to solve canonical problems analytically and computationally

CO2: Model and simulate simple physical systems using ordinary differential equations

CO3: Apply the concept of probability and random variables to solve elementary real-life problems

CO4: Explain the basic concepts of quantum computing and differentiate it from conventional computing.

Syllabus:

Unit 1: Basics of Linear Algebra - Linear Dependence and independence of vectors - Gaussian Elimination - Rank of set of vectors forming a matrix - Vector space and Basis set for a Vector space – Dot product and Orthogonality -CR decomposition - Rotation matrices - Eigenvalues and Eigenvectors and its interpretation- Introduction to SVD, Computational experiments using Matlab/Excel/Simulink.

Unit 2: Ordinary Linear differential equations, formulation - concept of slope, velocity and acceleration - analytical and numerical solutions- Impulse Response computations- converting higher order into first order equations - examples of ODE modelling of falling objects, satellite and planetary motion, Electrical and mechanical systems– Introduction to solving simple differential equations with Simulink- Introduction to one variable optimization - Taylor series- Computational experiments using Matlab /Excel/Simulink.

Unit 3: Introduction to random variables (continuous and discrete), mean, standard deviation, variance, sum of independent random variable, convolution, probability distributions.

Unit 4: Introduction to quantum computing, Quantum Computing Roadmap, Quantum Mission in India, A Brief Introduction to Applications of Quantum computers, Quantum Computing Basics, Bracket Notation, Inner product, outer product, concept of state.

Text Books / References:

1. Gilbert Strang, Introduction to Linear Algebra, Fifth Edition, Wellesley-Cambridge Press, 2016.
2. Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.
3. William Flannery, Mathematical Modelling and Computational Calculus, Vol-1, Berkeley Science Books, 2013.
4. Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares, 2018.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	-	2	-	-	-	2	2	-	2	1	1	1
CO2	3	3	1	-	2	-	-	-	2	2	-	2	1	1	1
CO3	3	3	1	-	2	-	-	-	2	2	-	2	1	1	1
CO4	3	2	2	-	2	-	-	-	2	2	-	2	1	1	1

Course Objectives:

- Enable students to effectively apply computational thinking principles, including critical thinking, data representation, abstraction, decomposition, and problem-solving algorithms to solve complex engineering problems.
- Equip students with skills to proficiently use spreadsheet tools for implementing and solving problems, such as fractals, calculus, and probability, through basic operations, cell references, and lookup operations.
- Foster students' competence in MATLAB, covering basic operations, vector plotting, array and matrix operations, for implementing and solving mathematical problems, including Micro-credentials, calculus-based challenges, and probability-related scenarios.
- Facilitate the integration of computational thinking across platforms, to solve diverse engineering problems, fostering a holistic understanding of computational methodologies in practical applications.

Course Outcomes:

After completing this course, students should be able to

CO1: Proficiently apply computational thinking, including critical thinking, data representation, abstraction, and decomposition, to solve complex engineering problems.

CO2: Effectively use spreadsheet to solve problems related to Micro-credentials, calculus, and probability.

CO3: Apply computational algorithms using MATLAB, including basic operations, vector plotting, array and matrix operations, to solve mathematical problems such as Micro-credentials, calculus-based problems, and probability-related challenges.

CO4: Integrate computational thinking skills across multiple domains, fostering a holistic understanding of computational methods in real-world applications.

Syllabus:

Unit 1: Computational thinking, critical thinking, data representation, abstraction, decomposition- breaking problems into parts, basic data types, pseudocode, algorithms-methods to solve the problems, brute-force or exhaustive search problems, divide and conquer problems

Unit 2: Computational thinking using spreadsheets, basic operations, cell references – relative and absolute, lookup operations, implement fractals – newton, Sierpinski triangle, L-system Micro-credentials, solve calculus-based problems using spreadsheet, using spreadsheet for solving probability related problems

Unit 3: Computational thinking using matlab, basic operations, plotting of vectors, array and matrix operations, implement fractals – newton, Sierpinski triangle, L-system fractals, solve calculus based problems using matlab, using matlab for solving probability related problems

Text Books / References:

1. Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018
2. Beecher K. Computational Thinking: A beginner's guide to Problem-solving and Programming. BCS Learning & Development Limited; 2017.
3. Irfan Turk, Matlab programming, 2018
4. Noreen Brown, Beginning Excel 2019, 2019.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	-	-	-	2	2	-	2	2	1	2
CO2	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
CO3	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
CO4	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2

Course Objectives:

- Develop a foundational understanding of the structural biochemistry of essential biomolecules, including sugars, amino acids, nucleic acids, carbohydrates, and lipids, along with their polymers.
- Explore the sub-cellular organizations and architectures, delving into cell biology concepts related to membranes, nuclei, golgi apparatus, cytoskeleton, tissues, organs, and systems, with a focus on human morphology, histology, and anatomy.
- Gain insights into classical enzymology, murzymes, and the basics of routine metabolism, including principles of thermodynamics, kinetics, and structure-function correlations.
- Acquire comprehensive overviews of the organization of life, encompassing cell theory, the central dogma, and the murburn concept.

Course Outcomes:

After completing this course, students should be able to

CO1: Apply knowledge of structural biochemistry to identify and understand the functions of essential biomolecules and their polymers.

CO2: Analyze and comprehend the sub-cellular structures and organizations, including membranes, nuclei, golgi apparatus, cytoskeleton, tissues, organs, and systems, with a specific emphasis on human morphology, histology, and anatomy.

CO3: Demonstrate a clear understanding of classical enzymology, murzymes, and routine metabolism, applying principles of thermodynamics, kinetics, and structure-function correlations.

CO4 : Integrate knowledge of the organization of life, including cell theory, the central dogma, and murburn concept, providing a comprehensive understanding of fundamental biological processes.

Syllabus:

Unit 1: Molecules of life (Structural Biochemistry: sugars, amino acids, nucleic acids, carbohydrates, lipids, etc. and their polymers)

Unit 2: Sub-cellular organizations & architectures (Cell Biology: membrane, nucleus, golgi apparatus, cytoskeleton, etc.) & tissues, organs, and systems (General morphology/histology/anatomy, particularly human)

Unit 3: Classical enzymology & murzymes; basics of routine metabolism (thermodynamics, kinetics, structure-function correlations)

Unit 4: Comprehensive overviews on organization of life (cell theory, central dogma and murburn concept)

Textbook / References:

1. Nelson, D.L. and Cox, M.M. (2017) Lehninger Principles of Biochemistry. 7th Edition, W.H. Freeman, New York, 1328.

2. Basic concepts in biochemistry: A student's survival guide by Hiram F Gilbert. pp 298. McGraw-Hill, NY. 1992.

3. Bruce Alberts ... [and others]. Molecular Biology of the Cell. New York :Garland Pub., 1989.

4. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (2002) Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi.

5. Mescher A.L.(Ed.), [publicationyear2] *Junqueira's Basic Histology: Text and Atlas, 15e*. McGraw-Hill Education. https://accessmedicine.mhmedical.com/content.aspx?bookid=2430&sectionid=190220001

6. Richard L. Drake, A. Wayne Vogl**,** Adam W. M. Mitchell. Gray's anatomy for students. Elsevier. ISBN : 9780323934237

7. Murburn concept in cellular function and bioenergetics: Part 1: Understanding murzymes at the molecular level. https://doi.org/10.1063/5.0171857 Manoj et al.

8. Murburn concept in cellular function and bioenergetics: Part 1: Understanding integrations-translations from molecular to macroscopic levels. https://doi.org/10.1063/5.0171860 Manoj et al.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO2	-	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO3	-	2	2	-	-	-	-	-	2	2	-	2	3	3	3
CO4	3	2	-	-	-	-	-	-	2	2	-	2	3	3	3

Course Objectives:

- Develop an understanding of the foundational principles in science, engineering, and project procedures, including the distinctions between science, non-science, and engineering, and the identification of project goals.
- Acquire skills in scientific and technical documentation, literature review, and effective utilization of relevant literature in the context of biomedical projects.
- Gain knowledge and awareness of safety practices, regulations, and ethical considerations associated with biomedical projects.
- Conceptualize projects, including project analysis, statistical methods, and the interpretation of data, fostering critical thinking and problem-solving skills.

Course Outcomes:

After completing this course, students should be able to

CO1: Distinguish between science, non-science, and engineering principles and set clear goals for biomedical projects.

CO2: Effectively utilize scientific and technical documentation and literature to inform and enhance their biomedical project work.

CO3: Demonstrate knowledge of safety practices, regulations, and ethical considerations relevant to biomedical projects.

CO4: Conceptualize and analyze biomedical projects, apply statistical methods, and interpret data critically, preparing them for effective problem-solving in the field.

Syllabus:

Unit 1: Science (& non-science) & engineering, procedures and goals

Unit 2: Scientific/technical documentation & literature

Unit 3: Safety, practices and regulation aspects

Unit 4: Conceptualization of a project, analysis, statistics and interpretations

Unit 5: Communication/Presentation of a project/research report

Textbook/References

1. https://ccsuniversity.ac.in/bridge-library/pdf/Research-Methodology-CR-Kothari.pdf

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	-	-	-	-	-	2	2	2	2	2	1	3	1
CO2	-	3	-	-	3	-	-	2	2	2	-	2	1	3	1
CO3	-	-	-	-	-	-	3	2	2	2	3	2	1	3	1
CO4	-	3	-	3	-	-	-	2	2	2	2	2	1	3	1

Course Objectives:

- Develop a solid understanding of the fundamental principles of electrical engineering, including circuit analysis, electronic components, and their applications in medical devices.
- Apply knowledge of electronic circuits and signal processing techniques to design and analyze circuits used in medical devices, ensuring their relevance and effectiveness in healthcare applications.
- Integrate sensors and actuators effectively into medical systems, demonstrating the ability to select, interface, and troubleshoot these components for optimal functionality in AI-driven medical engineering.
- Emphasize safety considerations in the design and implementation of electrical and electronic systems in medical technology, understanding regulatory requirements and ethical considerations to ensure compliance with industry standards.

Course Outcomes:

After completing this course, students should be able to

CO1: Demonstrate proficiency in designing and analyzing electrical circuits, with a specific focus on applications in medical devices, ensuring a solid foundation in electrical engineering principles

CO2: Apply electronic circuitry and signal processing techniques to design and simulate circuits for medical applications, fostering the ability to contribute to the development of advanced medical devices.

CO3: Integrate sensors and actuators into medical systems, demonstrating the ability to select appropriate components, design sensor-actuator systems, and troubleshoot issues to ensure reliable performance.

CO4: Apply skills to design electrical and electronic systems in compliance with safety standards, and regulations in healthcare technology.

Syllabus:

Unit 1: Overview of electrical engineering in medical applications and biological principles- Significance of electrical principles in healthcare technology- Electrical quantities and units- Ohm's Law, Kirchhoff's Laws- Series and parallel circuits- Node and mesh analysis- Thevenin and Norton theorems- Resistors, capacitors, inductors-AC fundamentals- Diodes, transistors, operational amplifiers- Circuit design in medical instruments- safety considerations

Unit 2: Introduction to signals and systems- Analog and digital signals- Frequency domain analysis- Amplifiers and filters in medical devices- Analog-to-digital and digital-to-analog converters- Noise analysis and reduction techniques- requirements for medical devices Voltage regulation and power management Battery technologies in healthcare applications- Reliability and failure analysis Electromagnetic compatibility (EMC) in medical electronics Regulatory considerations for electronic medical devices

Unit 3: Types of sensors in medical applications Sensor characteristics and specifications Sensor interfacing with microcontrollers- Introduction to actuators in medical systems Case studies on actuator-driven medical devices Feedback control systems in healthcare technology- Design principles for sensor-actuator systems Real-time monitoring and control in medical applications Challenges and opportunities in smart medical device

Text Books / References

1. “Basic Electrical Engineering” by D. P. Kothari and J. Nagrath (4th edition), McGraw Hill, 2019.
2. "Electric Circuits" by James W. Nilsson and Susan Riedel (11th edition), Pearson, 2018.
3. "Medical Instrumentation:Application and Design" by John G Webster,Amit J Nimunkar, Wiley 2020
4. “Sensors and Actuators in Mechatronics” by Andrezj M Pawlak, Taylor and Francis Group, 2007

CO-PO mapping

PO/ PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	-	-	-	2	2	3	2	-	2	-
CO2	3	3	3	3	3	-	-	-	2	2	3	2	2	-	-
CO3	3	2	3	3	3	-	-	-	2	2	3	2	1	2	3
CO4	3	3	3	3	2	-	-	-	2	2	3	2	2	2	-

22AVP103 Mastery Over Mind (MAOM) 1-0-2 2

1. Course Overview

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organise university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3). This program as part of our efforts for sustainable stress reduction gives an introduction to immediate and long-term benefits and equips every attendee to manage stressful emotions and anxiety facilitating inner peace and harmony.

With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university's mission: "Education for Life along with Education for Living", and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

2. Course Syllabus

Unit 1 (4 hours)

Causes of Stress: The problem of not being relaxed. Need for meditation -basics of stress management at home and workplace. Traditions and Culture. Principles of meditation– promote a sense of control and autonomy in the Universal Human Value System. Different stages of Meditation. Various Meditation Models. Various practices of Meditation techniques in different schools of philosophy and Indian Knowledge System.

Unit 2 (4 hours)

Improving work and study performance. Meditation in daily life. Cultivating compassion and good mental health with an attitude of openness and acceptance. Research and Science of Meditation: Significance of practising meditation and perspectives from diverse fields like science, medicine, technology. philosophy, culture, arts, management, sports, economics, healthcare, environment etc. The role of meditation for stress and anxiety reduction in one's life with insights based on recent cutting-edge technology. The effect of practicing meditation for the wholesome wellbeing of an individual.

Unit 3 (4 hours)

Communications: principles of conscious communication. Relationships and empathy: meditative approach in managing and maintaining better relationships in life during the interactions in the world, role of MAOM in developing compassion, empathy and responsibility, instilling interest, and orientation to humanitarian projects as a key to harness intelligence and compassion in youth. Methodologies to evaluate effective awareness and relaxation gained from meditation. Evaluating the global transformation through meditation by instilling human values which leads to service learning and compassion driven research.

TEXT BOOKS:

1.Mata Amritanandamayi Devi, “Cultivating Strength and vitality,” published by Mata Amritanandamayi Math, Dec 2019
2.Swami Amritaswarupananda Puri ,”The Color of Rainbow “ published by MAM, Amritapuri.

REFERENCES:

1.Craig Groeschel, “Winning the War in Your Mind: Change Your Thinking, Change Your Life” Zondervan Publishers, February 2019

2.R Nagarathna et al, “New Perspectives in Stress Management “Swami Vivekananda Yoga Prakashana publications, Jan 1986

3. Swami Amritaswarupananda Puri “Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation”, August 2019
4. Swami Amritaswarupananda Puri “From Amma’s Heart - Amma’s answer to questions raised during world tours” March 2018
5. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
6. Mata Amritanandamayi Devi “Compassion :The only way to Peace:Paris Speech”, MA Center, April 2016.
7. Mata Amritanandamayi Devi “Understanding and collaboration between Religions”, MA Center, April 2016.
8. Mata Amritanandamayi Devi “Awakening of Universal Motherhood: Geneva Speech” M A center, April 2016.

3. Evaluation and Grading

Internal			**External**	**Total**
Components	*Weightage*		Practical (attendance and class participation) 60%	100%
Quizzes(based on the reading material)	20%	40%		
Assignments (Based on webinars and lecture series)	20%			

4. Course Outcomes (CO)

CO1: Relate to the causes of stress in one’s life.
CO2: Experiment with a range of relaxation techniques CO3: Model a meditative approach to work, study, and life.
CO4: Develop appropriate practice of MA-OM technique that is effective in one’s life CO5: Inculcate a higher level of awareness and focus.
CO6: Evaluate the impact of a meditation technique

***Programme Outcomes(PO)**(As given by NBA and ABET)

PO1: Engineering Knowledge

PO2: Problem Analysis

PO3: Design/Development of Solutions

PO4: Conduct Investigations of complex problems

PO5: Modern tools usage

PO6: Engineer and Society

PO7: Environment and Sustainability

PO8: Ethics

PO9: Individual & Team work

PO10: Communication

PO11: Project management & Finance

PO12: Lifelong learning

CO – PO Affinity Map

P O / C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS 01	PSO2	PSO3
CO1	3	3	3	2		-	2	3	-	3	-	3	-	-	-
CO2	3	3	3	2	2	_	2	3	3	3	-	3	-	-	-
CO3	3	3	2	2	2	2	2	3	3	3	-	3	-	-	-
CO4	3	3	3	2	-	2	3	3	3	3	-	3	-	-	-
CO5	3	2	2	2	-	2	-	3	2	2	-	2	-	-	-
CO6	3	2	2	2	3	2	_	3	2	2	-	2	-	-	-

22AVP212- Amrita Value Programme-Introduction to Indian traditional systems of medicine Credits: 1 Weekly: 1-0-0

Course objectives:

It Provides students with a historical overview of traditional systems of medicine in India, tracing their origins and evolution over time. Introduce students to major traditional systems of medicine in India, such as Ayurveda, Yoga, Siddha and others. Examine the philosophical principles that underpin Indian traditional medicine, including concepts of balance, harmony, and holistic well-being.

Course Outcomes:

After completing this course, students should be able to

CO1: Identify and understand India's major systems of traditional health and trace their historical and theoretical roots.

CO2: Analyze the concept of "holistic health" and discuss its significance in diverse Indian/South Asian Philosophical perspectives.

CO3: Demonstrate how traditional health practices are both supportive of and alien to a modern allopathic health approach, with examples.

CO4: Discuss the intersections of globalization a modern development agenda and environmental change with traditional health and medicine practices in northern India.

Syllabus:

Unit 1 : Introduction to India; health care in India, introduction to traditional health; defining "holistic;" philosophy and well-being in the Indian context.

Unit 2 : Explorations of naturopathy and Ayurveda including their approaches to diet and lifestyle in healing and fostering health.

Unit 3 : The nature of naturopathy; the theory of the three humors in Ayurveda; herbal medicine; revitalization; acupuncture; panch karma the uses of water therapy; physical and mental health**.**

Reference:

1.Bhasin Veena. Medical Anthropology: Healing Practices in Contemporary Sikkim. www.krepublishers.com/...Bhasin-Veena/Anth-SI-03-7-Bhasin-Veena.

2. Capila Anjali. Traditional Health Practices of Kumaoni Women, Continuity and Changes. New Delhi: Concept Publishing Company, 2004.

3. Indal Rakesh. Philosophy of Nature Cure, Science of Natural Life. Arogya Sewa Prakashan, Modi Nagar, UP, 2010.

4. National Policy on Indian Systems of Medicine & Homoeopathy-2002, AYUSH Section, Ministry of Health & Family Welfare, Government of India, New Delhi.

5. Palep H.S. "Chemistry of Life in Ayurveda," Scientific Foundation of Ayurveda. New Delhi: Chaukhamba Sanskrit Pratishthan, 2004.

6. Panda K Ashok, Misra Sangram. "Health Tradition of Sikkim Himalaya." Journal of Ayurveda & Integrative Medicine, Vol 1, Issues 3, July 2010.

7. Singh R.H. , Sharma P.V. Panchakarma Sarira, Panchakarma Therapy. New Delhi: Chaukhamba Sanskrit Pratishthan, 2010.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	3	-	-	-	-	-	-	-	-	1	-	1
CO2	2	-	-	-	-	-	-	-	-	-	-	-	1	-	1
CO3	-	-	-	-	-	2	-	-	-	-	-	-	1	-	1
CO4	-	-	-	3	-	-	-	-	-	-	-	-	1	2	1

Items listed below (A to D) may change owing to temporal mandates and developments.

A. 24AIM131 - Introduction to ML – Decision trees, Clustering, Regression

CO: The student should be able to develop validated classification and regression models for real world problems

What is data mining? Examples of data mining
Input: concepts, instances, attributes
Different types of attributes
Output: Knowledge representation
Decision Trees, Regression, clustering.
Mathematics behind Decision trees
Regression - Formulation -Solution in Excel
Classification- formulation as regression- solution in Excel
Training, testing, cross-validation

References:

1. https://www.cs.waikato.ac.nz/ml/weka/book.html
2. Videos:https://www.cs.waikato.ac.nz/ml/weka/courses.html

B. 24AIM132 WEKA tool for ML 3 0 2 4

CO: The student should be able to visualize and mine data using WEKA.

Downloading and Installation
Understanding Weka User inteface options
Familiarising various data sets and data formats
Data loading and visualization
Concept of Preprocessing
Various Preprocessing options
Familiarizing Datamining tools: classification, regression and Clustering
Practicing with various data sets

References:

1. https://www.cs.waikato.ac.nz/ml/weka/book.html
2. https://www.cs.waikato.ac.nz/ml/weka/courses.html

C. 24AIM133 Chemical Molecular representation for AI Metrices, SMILES, SELFIES 3 0 2 4

CO: The student should be able to featurize molecules through 2D/graphical and 3D representations for cheminformatic applications.

Types of Molecular Bonds and inter-molecular interactions
Molecular Graphs, 2-D and 3-D representations
Chirality of Molecules, Featurizing a Molecule
SMILES Strings and SELFIES
RDKit, Families of Molecular Descriptors
Molecular shape, electrostatics
Introduction to Thermodynamics - Free Energy of protein-ligand binding
Rates of Chemical Reactions - Introduction to Chemical Kinetics

References:

1. Chapter 4 Machine Learning for Molecules of the book :Deep Learning for the Life Sciences" Bharath Ramsundar et.el

2. N. Sukumar, Harishchander Anandaram and Pratiti Bhadra, “Computational Drug Discovery – A Primer” (Ion Cures Press, 2023). ISBN: 979-8850083663
3. SELFIES and the future of molecular string representations:
4. https://arxiv.org/pdf/2204.00056.pdf
5. https://github.com/aspuru-guzik-group/selfies

D. 24AIM134 Use of AR and VR in medicine 3 0 2 4

CO: The student should be able to use AR/VR for deriving spatio-temporal awareness of cellular structure-function and human anatomy/physiology aspects.

Software and Hardware for AR VR
Hand on with the AR-VR systems
What is Virtual Reality? Non-immersive VR, Semi-immersive VR
An example of training in VR https://vimeo.com/690217500
The Body VR: Anatomy Viewer, Complete Anatomy Platform

References:

1. https://thebodyvr.com/anatomy-viewer/
2. https://3d4medical.com/
3. https://appsource.microsoft.com/en-us/product/web-apps/virtualmedicinesro.human_anatomy_vr?tab=overview
4. https://www.simxvr.com/
5. https://www.ossovr.com/
6. https://www.mcw.edu/-/media/MCW/Education/Academic-Affairs/OEI/Faculty-Quick-Guides/Virtual-Reality-in-Medical-Education.pdf
7. https://redir.ebookpromotions.online/library/virtual-reality-in-higher-education.pdf
8. http://web.cecs.pdx.edu/~aryafare/course-material-VR/Lec1.pdf
9. Yapıcı, İ. Ü. & Karakoyun, F. (2021). Using augmented reality in biology teaching. Malaysian Online Journal of Educational Technology
10. Fatih Aydoğdu et.al , Uses of Augmented Reality in Preschool Education, International Technology and Education Journal Vol. 5 No. 1; June 2021.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
A	3	3	3	3	1	-	-	-	2	2	-	2	2	1	2
B	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
C	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
D	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2

Semester II

23MAT112 **Mathematics for Intelligent Systems 2** **2 0 2 3**

Course Objectives:

- To introduce students to the fundamental concepts of linear algebra, differential equations, optimization, and probabilistic modelling.
- To enable students to apply the concepts they learn in practical situations by using analytical and numerical methods to model real-world problems.
- To expose students to the wide range of applications of linear algebra, ordinary differential equations, probability theory, and quantum computing within the scientific field and to inspire them to pursue further study or research in these areas.
- To equip students with advanced mathematical knowledge and problem-solving skills highly valued in various industries and research fields.

Course Outcomes:

After completing this course, students should be able to
CO 1: Apply matrix decomposition techniques to solve linear systems of equations.
CO 2: Formulate optimization problems and solve them using gradient based and Newton's methods
CO 3: Analyse data using fundamental techniques of probability.
CO 4: Explain quantum entanglement, qubits and state vectors

Syllabus:

Unit 1: Gaussian elimination – LU decomposition – Vector spaces associated with Matrices- Special orthogonal matrices - Fourier Series and Fourier Transform and its properties – Convolution - Projection matrix and Regression - Convolution sum - Convolution Integral - Eigenvalues and Eigenvectors of Symmetric matrices - Eigenvalues and Eigen vectors of ATA, AAT - Relationship between vector spaces associated with A, ATA, AAT- Singular Value Decomposition – Concept of Pseudoinverse- Computational experiments using MATLAB/Excel/Simulink

Unit 2: Taylor series expansion of multivariate functions-conditions for maxima, minima and saddle points- Concept of gradient and Hessian matrices - Multivariate regression and regularized regression -Theory of convex and non-convex optimization-Newton method for unconstrained optimization- Signal processing with regularized regression- Impulse Response computations- converting higher order into first order equations – concept of eAT- Computational experiments using MATLAB/Excel/Simulink

Unit 3: Random variables and distributions - Expectation, Variance, Moments, Cumulants- Moment generating functions - Sampling from univariate distribution- various methods - Bayes theorem, Concept of Jacobian, and its use in finding pdf of functions of Random variables (RVs), Box-muller formula for sampling normal distribution - Concept of correlation and Covariance of two linearly related RVs

Unit 4: Introduction to quantum computing–Introduction to spin – state vectors – Qubits – Entanglement. Measurement in Quantum Mechanics.

Textbooks / References:

1. Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.
2. William Flannery, Mathematical Modelling and Computational Calculus, Vol-1, Berkeley Science Books, 2013.
3. Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares, 2018.
4. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc
5. Bernhardt, Chris. Quantum computing for everyone. Mit Press, 2019. (From pages 37 to 70).

CO-PO Mapping

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	3	-	-	-	2	2	-	2	2	2	-
CO2	3	2	1	1	3	-	-	-	2	2	-	2	2	1	-
CO3	3	2	1	1	3	-	-	-	2	2	-	2	2	2	-
CO4	3	2	1	1	3	-	-	-	2	2	-	2	2	2	-

24AIM111 Introduction to data structure and algorithms 2-0-2 3

Course Objectives

- This course aims to introduce students to the concept of data structures, and demonstrate how the use of appropriate data structures will improve the efficiency of algorithms.
- Students will implement various simple data structures and apply them to solve real world scenarios.
- Along the way, students will learn to think about problems recursively and use modular programming.

Course Outcomes

After completing this course, the student should be able to

CO1: Apply modular design to write simple, correct and recursive programs.

CO2: Apply elementary mathematical concepts to prove the correctness and analyze the complexity of algorithms.

CO3: Design and implement simple augmented data structures to model various real world scenarios.

CO4: Use appropriate data structures to write efficient algorithms.

Syllabus:

Unit 1: Data Structure – primitive and non-primitive, Array data structure, properties and functions, single and multiidimensional arrays, simple problems, Basics of Algorithm Analysis, big-Oh notation, notion of time and space complexity, dynamic arrays

Unit 2: Linked List - singly linked list, doubly linked list, circular linked list- properties and functions, implementations, sorting algorithms – selection, bubble, insertion, quick sort, merge sort, comparison of sorting algorithms, implementation using arrays.

Unit 3: Stack data structure, properties and functions, recursion, expression evaluation, Queue data structure - circular queue, double ended queue, properties, and functions

Unit 4: Binary Tree– arrays and linked list representation, tree traversals-preorder, postorder, inorder, level order. Graphsdirected and undirected graphs, adjacency list and matrices, Incidence matrices, path, graph traversals – breadthfirst and depth-first, Shortest path- Dijkstra's algorithm, Bellman-Ford algorithm, Floyd-Warshall algorithm.

Text Books / References:

1. Alfred V Aho, John E Hopcroft, Jeffrey D Ullman. Data Structures & Algorithms, Pearson Publishers, 2002.
2. Maria Rukadikar S. Data Structures & Algorithms, SPD Publishers, 2011.
3. Michael T. Goodrich & Roberto Tamassia, Data Structures and Algorithms in Java,Wiley India Edition, Third Edition
4. Narasimha Karumanchi, Data Structures and Algorithms Made Easy in Java, CarrerMonk, 2011 Y. Langsam, M. Augenstin and A. Tannenbaum, Data Structures using C and C++, Pearson Education, 2002.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	-	-	-	2	2	-	2	2	1	2
CO2	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2

CO3	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
CO4	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2

24AIM112 Molecular biology and basic cellular physiology 2 0 2 3

Course Objectives:

- Develop a fundamental understanding of basic molecular biology concepts, including genes, exons, introns, histones, chromatin accessibility, and transcription factors.
- Explore overall metabolic crossovers, including biological gates and switches, transcription regulation, feed-forward and feedback loops
- Understand cellular and systemic powering, homeostasis, coherence, and murburn concept.

Course Outcomes:

After completing this course, students should be able to

CO1: Analyze and interpret fundamental molecular biology concepts, including the structure and control mechanisms of cells.

CO2: Demonstrate and apply concepts related to metabolic crossovers, biological gates, switches, transcription regulation, and the principles of systems biology.

CO3: Develop an understanding of cellular and systemic powering, homeostasis, coherence, and the murburn concept, including the interactions of cells with xenobiotics and their roles in cell-cell, cell-matrix, and cell-environment interactions.

Syllabus:

Unit 1: Cells and their long-term structure-control mechanisms (basic molecular biology: genes, exons, introns, histones, chromatin accessibility, transcription factors, etc.)

Unit 2: Overall metabolic crossovers (Biological gates and switches, Transcription Regulation, Feed-forward and Feedback loops, Biological Networks, Introduction to Systems biology)

Unit 3: Cellular/systemic short-term powering & homeostasis & coherence, murburn concept (including xenobiotics and their modes of interaction), Cell-cell, cell-matrix, cell-environment interactions, etc.

Textbook / References:

1. Nelson, D.L. and Cox, M.M. (2017) Lehninger Principles of Biochemistry. 7th Edition, W.H. Freeman, New York, 1328.
2. Basic concepts in biochemistry: A student's survival guide by Hiram F Gilbert. pp 298. McGraw-Hill, NY. 1992.
3. Bruce Alberts ... [and others]. Molecular Biology of the Cell. New York :Garland Pub., 1989.
4. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (2002) Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi.
5. Mescher A.L.(Ed.), [publicationyear2] *Junqueira's Basic Histology: Text and Atlas, 15e*. McGraw-Hill Education. https://accessmedicine.mhmedical.com/content.aspx?bookid=2430&sectionid=190220001
6. Richard L. Drake, A. Wayne Vogl**,** Adam W. M. Mitchell. Gray's anatomy for students. Elsevier. ISBN : 9780323934237
7. Gloria Doran, Cell physiology. Callisto Reference. ISBN-10:163239815X
8. Stuart Ira Fox Dr and Krista Rompolski Human physiology by Fox & Rompolsk
9. Dunecan Massey & Imran Noorani. Carpenter's Neurophysiology: A Conceptual Approach. ISBN-10 : 0367340607
Neurophysiology by Carpenter
10. Murburn concept in cellular function and bioenergetics: Part 1: Understanding murzymes at the molecular level. https://doi.org/10.1063/5.0171857 Manoj etal.

11.Murburn concept in cellular function and bioenergetics: Part 1: Understanding integrations-translations from molecular to macroscopic levels. https://doi.org/10.1063/5.0171860 Manoj etal.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO3	PSO4
CO1	3	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO2	-	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO3	-	2	-	-	-	-	-	-	2	2	-	2	3	3	3

24AIM113 Introduction to NN, CNN and GNN 2 0 2 3

Course Objectives:

- Develop a comprehensive understanding of neural networks, covering linear and logistic regression, artificial neurons, single and multi-layer perceptrons, activation functions, and feed-forward network functions.
- Explore regularization techniques for deep learning, including dataset augmentation, noise robustness, semi-supervised learning, multi-task learning, early stopping, and ensemble methods.
- Understand convolutional networks, including the convolution operation, pooling, variants of the basic convolution function, and famous convnet architectures like AlexNet, VGG, ResNet, and EfficientNet.

Course Outcomes:

After completing this course, students should be able to
CO1: Implement deep neural networks and Convolutional Neural Networks for solving problems.
CO2: Employ regularization techniques in deep learning to enhance model robustness and generalization.
CO3: Use transfer learning concepts to solve problems.
CO4: Implement Graph Neural Network to learn the structural relationship in data.

Syllabus:

Unit 1: Neural Networks: Basic concepts of artificial neurons, single and multilayer perceptron, perceptron learning algorithm, activation functions, loss function. Feed-forward Network Functions - Network Training – Backpropagation - Parameter optimization – Hyperparameter Tuning

Unit 2: Regularization for Deep Learning: Dataset Augmentation - Noise Robustness - Early Stopping - Dropout - Sparse Representation - Bagging and Other Ensemble Methods – Semi-Supervised Learning - Multi-Task Learning - Parameter Tying and Parameter Sharing

Unit 3: Convolutional Networks: The Convolution Operation - Motivation - Pooling - Convolution and Pooling as an Infinitely Strong Prior - Variants of the Basic Convolution Function - ConvNet Architectures – Transfer learning

Unit 4: Graph representation learning - Node embedding models - Knowledge graph embedding models - Graph neural networks - Graph neural network architectures - Graph neural networks and knowledge graphs

Textbooks / References

1. Ian Good Fellow,YoshuaBengio, and Aaron Courville. *Deep Learning,* MIT Press, 2016.
2. C. M. Bishop. *Pattern Recognition and Machine Learning*, Springer, 2006.
3. Nikhil Buduma. *Fundamentals of Deep Learning*, First Edition, O'REILLY Media, 2017.
4. M. Mohri, A. Rostamizadeh, and A. Talwalkar. *Foundations of Machine Learning*, MITPress, 2012.
5. Kevin P. Murphy. *Machine Learning: A Probabilistic Perspective,* MIT Press, 2012.
6. D. Barber. *Bayesian Reasoning and Machine Learning*, Cambridge University Press, 2012.
7. https://nptel.ac.in/courses/106105152/
8. William L. Hamilton (2020), Graph Representation Learning, Synthesis Lectures on AI and ML, Vol. 14, No. 3.

CO-PO mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	-	2	2	2	-	2	3	2	1
CO2	3	3	2	1	2	2	-	2	2	2	-	2	1	1	1
CO3	3	3	2	2	2	2	-	2	2	2	-	2	2	1	1
CO4	3	3	3	2	2	2	-	2	2	2	-	2	3	2	1

Course Objectives:

- Develop a foundational understanding of analog computing systems and differentiate between analog and digital systems.
- Acquire in-depth knowledge of op-amp characteristics, including DC and AC characteristics, and understand their applications in various amplifier configurations.
- Explore the design and applications of comparators, signal generators, and voltage regulators in analog systems.
- Gain proficiency in the design and analysis of active filters, including low pass, high pass, bandpass, and band reject filters, as well as data converters such as DACs and ADCs.

Course Outcomes:

After completing this course, students should be able to

CO1: Analyze analog computing systems, differentiating their key elements from digital systems.

CO2: Apply operational amplifiers in various configurations for amplification and signal processing.

CO3: Design signal generators, and voltage regulators for specific applications in analog systems.

CO4: Design active filters, including SC filters and data converters such as DACs and ADCs, meeting specified specifications in analog system design.

Syllabus:

Unit 1: Introduction to Analog Computing Systems: Analog systems versus Digital systems – Elements of analog system design, Op Amp Characteristics and Applications; Op-amp Block Diagram – Basic Differential Amplifier Configuration – Equivalent Circuit– DC Characteristics: Input bias current, Input offset current, Input offset voltage and Thermal drift – CMRR – AC characteristics: Slew rate and Frequency response; Op-amp Applications: Inverting, non-inverting and Differential Amplifiers – Scale Changer, Inverter, Inverting summing amplifier, Voltage follower, averager, Subtractor, Differentiator and Integrator, Log and Antilog Amplifiers, Multiplier and Divider, V to I and I to V Converters, Precision Rectifiers, Clipper and Clamper , Sample and Hold, Instrumentation Amplifier(using Three and Two op amp), AC Amplifier and Peak detector

Unit 2: Comparators: Comparator–Applications of comparator: Zero crossing detector, Phase angle detector, Time marker generator and Window detector– Schmitt Trigger – Astable multivibrator – Monostable Multivibrator – Triangular Wave Generator; Signal generators: RC Phase shift oscillator and Wein bridge oscillator; Regulators: Series op-amp regulator, Fixed or Three terminal IC voltage regulator, General purpose high voltage and low voltage regulator using IC 723, Switched mode regulator: Buck and Boost

Unit 3: Active filters: First order and second order low pass and high pass filter, wide and narrow band pass filter, Wide and narrow band reject filter – Switched Capacitor (SC) filter–SC Integrator – FDNR; Data Converters: Specifications of DAC and ADC – DAC: Binary weighted resistor, R-2R and Inverted R-2R ladder Network– ADC: Flash type, Counter type, Tracking or Servo Type, Successive Approximation Type, Charge Balancing and Dual Slope- Monolithic DAC.

Textbooks / References:

1. Gayakwad, Ramakant, A. Op-amps and Linear Integrated Circuits. 4th Edition, Prentice Hall of India Pvt. Ltd. 2009.
2. Roy Choudhury, D. and Jain, Shail, B. *Linear Integrated Circuits*. 4th Edition, New Age International publishers. 2010.
3. Coughlin, Robert, F. and Driscoll, Frederick, F. *Operational Amplifiers and Linear Integrated Circuits.* 6th Edition, Prentice Hall. 2001.
4. Sergio Franco. *Design with operational amplifiers and analog integrated circuit.,* 3rd Edition, Tata McGraw-Hill Education. 2002.
5. Sedra, Adel, S. and Smith, Kenneth, C. *Microelectronic circuits.* 5th Edition, Oxford University press. 2009.
6. NPTEL: http://nptel.ac.in/courses/117103063/

CO-PO-Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	-	-	-	2	2	-	2	2	1	2
CO2	3	3	3	2	2	-	-	-	2	2	-	2	2	1	2
CO3	3	3	3	2	2	-	-	-	2	2	-	2	2	1	2
CO4	3	3	3	2	2	-	-	-	2	2	-	2	2	1	2

Course Objectives:

- Develop a deep understanding of the fundamentals of ethics, including the historical evolution of free thought, modern ethical concepts, and the role of ethics in complex human societies.
- Analyze and critically evaluate case studies and issues in ethics, covering topics such as GMOs, transgenic animals, IVF, cloning, stem cell research, and various ethical dilemmas in biotechnology and healthcare.
- Gain knowledge of the classifications and procedures of Intellectual Property Rights (IPR).
- Explore the intersection of bioethics and business, understanding the patenting of higher organisms, bioprospecting, biopiracy, and the utilization of traditional knowledge systems in bio-businesses and entrepreneurship.

Course Outcomes:

After completing this course, students should be able to

CO1: Critically apply principles in the context of ethics, understanding the complexities of decision-making in healthcare and biotechnology.

CO2: Evaluate contemporary bioethical issues, demonstrating a nuanced understanding of the ethical implications of advanced biotechnological advancements.

CO3: Comprehend the classifications and procedures of IPR, enabling them to navigate and understand the legal and ethical dimensions of intellectual property in the context of biotechnology and medical engineering.

CO4: Assess the ethical and legal aspects of businesses, including patents for higher organisms, bioprospecting, and the entrepreneurial landscape in the medical sector.

Syllabus:

Unit 1: Fundamentals of Ethics: Historical persona and evolution of free thought, basic concepts of modern ethics- autonomy, rights, beneficence, non-maleficence, justice, animal rights, environmental protection etc. The complex nature of human society and role of ethics, right to information, conflicts in pillars of ethics and decision making, ethical committee's role, etc.

Unit 2: Case studies and issues in Bioethics: GMOs and transgenic animals, silicon womb, IVF, cloning humans, savior siblings, designer babies, allotransplantation, stem cell research, sexing the unborn, sex discrimination, monopolizing economy and starvation, biodiversity, gene therapy, clinical trials, etc.

Unit 3: Classifications & procedures of IPR: IPR in ancient societies, Pasteur, Chakrabarti and Leder of modern times, International cooperation; IPR and IPP - patents, copyrights, trademarks, geographical indications, industrial designs and other forms of IPRs and their classifications + scopes. General methods, procedures, obligations and implications involved in IPR & IPP, licensing and infringements.

Unit 4: Bio businesses: Patents for higher organisms – patenting transgenic organisms (plant breeder's rights and farmer's rights, PVP versus plant patenting etc.), higher animals and isolated genes, bioprospecting and biopiracy (neem, turmeric, basmati etc.), constructive utilization of traditional knowledge systems, PGR, IGF, UPOV etc. The classification of biobusinesses, the kind of money and the equations involved, successes and failures and reasons, entrepreneurship, etc.

References:

1. Genetic counselling, Diane.L.Baker, Wiley-Liss publications.
2. Genetics, society and clinical practice,(1997),Peter Harper, Bios scientific publishers Ltd.UK
3. Intellectual Property Rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology by Sibi G. (2020).
4. https://www.wipo.int/edocs/pubdocs/en/intproperty/932/wipo_pub_b932ipb.pdf

CO-PO mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	-	1	-	3	-	3	2	2	-	2	1	1	1
CO2	-	-	-	-	-	3	-	3	2	2	-	2	1	1	1
CO3	-	-	-	-	-	3	-	2	2	2	-	2	1	1	1
CO4	-	-	-	-	-	3	-	2	2	2	-	2	1	1	1

AMRITA VALUE PROGRAMME II

Items listed below (A to D) may change owing to temporal mandates and developments.

A. 24AIM141 - Patterns in Software Design (, Model view-controller, Command, Observer Pattern)

CO: The student should be able to use UML diagrams for software design

Introduction to Object oriented Programming in python
UML diagrams: Class and interaction
Gang of Four Design Patterns
Example patterns and implementation: Command, Observer, Model view-controller

References:

1. https://refactoring.guru/design-patterns/python
2.https://www.giacomodebidda.com/posts/mvc-pattern-in-python-introduction-and basicmodel/

B. 24AIM142 - Introduction to Linux operating system and commands

CO: The student should be able to work effectively with the LINUX operating system.

History of Linux operating system and commands
Installation
How to access the command line from your own computer, How to perform some basic file manipulation
Frequently used commands, How to chain commands together to make more powerful tools
Using administrator powers

References:

1. Richard Blum, Linux for dummies
2. https://ubuntu.com/tutorials/command-line-for-beginners#1-overview
3. https://www.csl.cornell.edu/courses/ece5745/handouts/ece4750-tut1-linux.pdf

C. 24AIM143 - Introduction to Internet and Protocols

CO: The student should be able to develop an understanding of computer networking protocols.

Types of computer networks.
Complexity, Divide and Conquer, OSI Reference Model
TCP/IP protocol
IP addressing Scheme
Routing Protocols

References:

1. TCP/IP Tutorial and Technical Overview
2. https://www.redbooks.ibm.com/redbooks/pdfs/gg243376.pdf
3. https://ics.uci.edu/~magda/cs620/ch4.pdf
4. TCP/IP and OSI Models Animation https://www.youtube.com/watch?v=p55ufXPWqBM
5. IPv4 - VLSM Animation https://www.youtube.com/watch?v=wJBOoqiApNg

D. 24AIM144 - Introduction to Data Compression

CO: The student should be able to work with different data compression schemes for text, image & video.

Information encoding: Fixed and Variable length encoding
Need for compression
Lossless compression, Information entropy, Huffman coding, Text Compression

Lossy compression, SVD and Image Compression
Discrete Cosine Transform, Image Compression, Video Compression

Reference:

1. Colt McAnlis, Aleks Haecky Understanding Compression , O'Reilly Media , 2016

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
A	3	3	3	3	1	-	-	-	2	2	-	2	2	1	2
B	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
C	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
D	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2

Semester III

Course Objectives:

- To provide students with advanced knowledge and skills in optimization, PDEs, probability and statistics, and quantum computing.
- To develop students proficiency in solving real-world problems in various domains, including physics, engineering, and computer science using the concepts of optimization, PDEs, and probability.
- To apply the concepts and techniques learned in the course to solve complex problems and communicate their solutions effectively to both technical and non-technical audiences.
- To equip students with advanced mathematical knowledge and problem-solving skills highly valued in various industries and research fields.

Course Outcomes:

After completing this course, students should be able to:
CO 1: Apply the fundamental techniques of optimization theory to solve data science problems.
CO 2: Analyse and solve computationally, physical systems using the formalism of partial differential Equations.
CO 3: Apply Markovian concepts in stochastic sequential systems.
CO 4: Explain Bells Inequality and Quantum gates.
Syllabus:

Unit 1: Direct methods for convex functions - sparsity inducing penalty functions- Constrained Convex Optimization problems - Krylov subspace -Conjugate gradient method - formulating problems as LP and QP – Lagrangian multiplier method-KKT conditions - support vector machines- solving by packages (CVXOPT) - Introduction to RKS - Introduction to DMD-Tensor and HoSVD- Linear algebra for AI.

Unit 2: Introduction to PDEs - Formulation and numerical solution methods (Finite difference and Fourier) for PDEs in Physics and Engineering- Computational experiments using Matlab/Excel/Simulink.

Unit 3: Multivariate Gaussian and weighted least squares - Markov chains - Markov decision Process

Unit 4: Introduction to quantum computing-Bells inequality-Quantum gates

Text Books / Reference Books:

1. Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.
2. Gilbert Strang, "Differential Equations and Linear Algebra Wellesley", Cambridge press, 2018.
3. Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares, 2018.
4. Bernhardt, Chris. Quantum computing for everyone. Mit Press, 2019. (From pages 71 to 140).

CO-PO Mapping

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	3	-	-	-	2	2	-	2	2	2	-
CO2	3	3	3	2	3	-	-	-	2	2	-	2	2	1	-
CO3	3	3	3	2	3	-	-	-	2	2	-	2	2	2	-
CO4	3	1	-	1	1	-	-	-	2	2	-	2	1	-	-

Course Objectives:

- Understand the fundamental principles of fluid mechanics and apply them to analyze physiological fluid behavior in artificial intelligence and biomedical engineering contexts.
- Explore the mechanical characteristics of blood vessels, blood rheology, and the dynamics of blood flow to comprehend their relevance in physiological systems.
- Investigate the microcirculation physiology, focusing on arterioles, capillaries, and the lymphatic system, and analyze the local control mechanisms.
- Develop proficiency in the measurement techniques of pressure and flow in physiological systems.

Course Outcomes:

After completing this course, students should be able to:

CO1: Apply fluid mechanics principles to analyze and model physiological fluid behavior in artificial intelligence and biomedical engineering contexts, enhancing their understanding of biomechanics.

CO2: Develop and understanding of the mechanical properties of blood vessels, blood flow dynamics, and the effects of turbulent flows in physiological systems, contributing to a comprehensive understanding of vascular biomechanics.

CO3: Explain the intricacies of microcirculation physiology, including arteriolar and capillary functions, and appreciate the role of the lymphatic system, fostering a holistic understanding of micro-level blood flow.

CO4: Apply practical skills in measuring pressure and flow in physiological systems using various techniques, thereby strengthening their competence in biomedical engineering applications.

Syllabus:

Unit 1: Fluid statics and kinematics: Fluid as a continuum, state of stress and fluid motion in physiology – conservation of mass, conservation of linear momentum (continuity, momentum equations);, first and second law of thermodynamics, introduction to heat transfer in physiology, pressure and force balances, velocity, acceleration fields; Differential analysis of fluid flow; Dimensional analysis – Reynolds number, Creeping or Stokes flow, Euler's, Bernoulli equation.

Unit 2: Fluidics in living systems and mechanobiology**:** Anatomy of blood vessels, arterial wall mechanics, blood cells and plasma, blood rheology, blood flow in arteries and veins, wave propagation in arterial system, flow separation, turbulent flows in physiological systems, pulsatile flow - Wormersley flow; surface tension driven flows, viscometers; pressure-flow relationships in blood; arterioles and local control, capillaries and mass exchange, heat transfer in microcirculation, lymphatic system – lymph physiology and lymphatic flow.

Unit 3: Measurement of pressure and flow in physiological system Pressure measurement - indirect measurement, direct – intravascular and catheter- transducer measuring system. Flow measurement – indicator dilution method – Fick technique, dye dilution, thermodilution, electromagnetic flow meters, doppler flow meter, nanoscale flows and molecular simulations lab demonstration, Lab on Chip microfluidics devices: Lab on chip devices: flow control, microfluidic mixing; Device fabrication; polymerase chain reaction (PCR); fabrication and detection aspects of lab-on-a-chip systems.

Text Books / Reference Books:

1. David A. Rubenstein et al., Biofluid Mechanics, 3rd Edition, Academic Press, 2022
2. L. White, Biofluid Mechanics in Cardiovascular System, McGraw Hill, 2006
3. C. Vlaschoppulos, Micheal O'Rourke and W. W. Nichols, McDonald's Blood Flow in Arteries, 6th edition, CRC Press, 2012
4. White, F.M., 2008. *Fluid mechanics*. The McGraw Hill Companies.
5. Kundu, P.K., Cohen, I.M. and Dowling, D.R., 2015. *Fluid mechanics*. Academic press.
6. KB Chandran, AP Yoganathan, SE Rittgers, Biofluid Mechanics: The Human Circulation, Taylor and Francis 2007.
7. Manz, A., Simone, G., O'Connor, J.S. and Neuzil, P., 2020. *Microfluidics and Lab-on-a-Chip*. Royal

Society of Chemistry.

CO-PO Mapping

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	-	-	-	2	2	-	2	2	1	1
CO2	3	3	3	3	2	-	-	-	2	2	-	2	2	1	1
CO3	3	3	3	3	2	-	-	-	2	2	-	2	2	1	1
CO4	3	2	2	2	1	-	-	-	2	1	-	2	1	1	1

24AIM202 Macroscopic and Systemic Physiology Credits: 3 Weekly: 2-0-2

Course Objectives:

- Develop a comprehensive understanding of the principles and logics governing cellular to systemic integration in multicellular organisms with a focus on hormonal and neuronal controls.
- Explore the molecular to macroscopic electrochemical and electromechanical outcomes, specifically in the context of bone-muscle interactions and neurophysiology.
- Understand the intricacies of complex human physiological systems, including circulatory, lymphatic, endocrine, reproductive, excretory, respiratory, and digestive systems.
- Gain insight into the functioning of the brain and central nervous system, exploring the principles of cybernetics and their role in systemic physiology.

Course Outcomes:

After completing this course, students should be able to

CO1: Analyze the integration of cellular processes into systemic functions, considering the influence of hormonal and neuronal controls.

CO2: Correlate molecular-level electrochemical and electromechanical outcomes with macroscopic physiological phenomena, particularly in bone-muscle interactions and neurophysiology.

C03: Describe the functioning of complex human physiological systems, including circulatory, lymphatic, endocrine, reproductive, excretory, respiratory, and digestive systems.

CO4: Analyze the principles of cybernetics and their application in understanding the brain and central nervous system's role in regulating physiological processes.

Syllabus:

Unit1 : The principles and logics of cellular to systemic integration using murburn concept: simple multicellular life to more complex beings with hormonal/neuronal controls, etc.

Unit 2: Molecular to macroscopic electrochemical & electromechanical outcomes: bone-muscles & neurophysiology.

Unit 3: Complex human systems: circulatory/lymphatic, endocrine, reproductive, excretory, respiratory, digestive, etc.

Unit 4: Brain and central nervous system: cybernetics

References / Textbooks:

1. A K Jain, A textbook of Physiology. Avichal, 2007. ISBN 8177391186

2. Hall, J., 2016. Guyton and Hall textbook of medical physiology, Elsevier.
3. ichael Weitz and Brian Kearns. Ganong's Review of Medical Physiology. Cenveo® Publisher
4. Murburn concept in cellular function and bioenergetics: Part 1: Understanding murzymes at the molecular level. https://doi.org/10.1063/5.0171857 Manoj etal.
5.Murburn concept in cellular function and bioenergetics: Part 1: Understanding integrations-translations from molecular to macroscopic levels. https://doi.org/10.1063/5.0171860 Manoj etal.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO3	PSO4
CO1	3	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO2	-	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO3	-	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO4	-	2	-	-	-	-	-	-	2	2	-	2	3	3	3

Course Objectives:

- Understand the foundational concepts of Natural Language Processing (NLP) and Large Language Models (LLM), including linguistic fundamentals and preprocessing techniques.
- Explore advanced NLP techniques, such as sentiment analysis, named entity recognition, and neural networks, as well as gain insights into language modeling.
- Acquire hands-on experience with popular NLP libraries and tools, and comprehend the principles behind pre-trained language models.
- Apply NLP and LLM concepts to real-world applications in AI and biomedical engineering, with a focus on ethical considerations and responsible AI.

Course Outcomes:

After completing this course, students should be able to:

CO1: Employ various NLP preprocessing techniques, including tokenization and feature extraction, to analyze and manipulate textual data effectively.

CO2: Apply advanced NLP techniques, such as sentiment analysis and part-of-speech tagging, and understand the architecture and training strategies of neural networks for NLP.

CO3: Utilize pre-trained language models for tasks like language understanding and generation, and fine-tune models for domain-specific applications.

CO4: Develop NLP solutions in AI and biomedical engineering, considering ethical implications and biases, ensuring responsible and impactful use of language models.

Syllabus:

Unit 1: Overview of Natural Language Processing (NLP) and its applications in AI and biomedical engineering, historical perspective and evolution of NLP. Understanding linguistic fundamentals: syntax, semantics, morphology, and phonetics.Tokenization, stemming, and lemmatization. Text Preprocessing and Feature Extraction: Techniques for cleaning and preprocessing textual data,Feature extraction methods for representing text data, including bag-of-words and TF-IDF. Introduction to popular NLP libraries such as NLTK, spaCy, and Hugging Face Transformers.

Unit 2: Statistical and Machine Learning Approaches: Overview of statistical and machine learning approaches in NLP. Sentiment analysis, named entity recognition, and part-of-speech tagging. Introduction to Language Models (LM): Understanding the concept of language modeling. Overview of traditional language models such as N-grams. Neural Networks for NLP: Introduction to neural networks in the context of NLP, Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks. Introduction to Transfer Learning in NLP: Overview of transfer learning and its application in NLP, Introduction to pre-trained language models.

Unit 3: Introduction to Large Language Models (LLM) : Overview of large language models such as GPT (Generative Pre-trained Transformer) and BERT (Bidirectional Encoder Representations from Transformers). Pre-training Language Models: Understanding the pre-training process for language models, Exploration of model architectures and training strategies. Fine-tuning Language Models: Techniques and considerations for fine-tuning pre-trained language models,Applications of fine-tuned models in specific domains, including biomedical engineering. Ethical Considerations in NLP: Discussion on ethical challenges and biases in NLP, Strategies for mitigating biases and ensuring responsible AI in NLP applications.

Unit 4: Applications in AI and Biomedical Engineering: NLP in Healthcare: Applications of NLP in healthcare and biomedical engineering, Case studies on text-based analysis of medical literature, electronic health records, and patient data. Biomedical Text Mining: Techniques for extracting information from biomedical texts, Exploration of literature mining and knowledge discovery in biomedicine. Advanced NLP Applications:

Overview of advanced NLP applications in AI, including chatbots, summarization, and question-answering systems, Practical projects applying NLP techniques to real-world scenarios. Future Trends in NLP and LLM: Exploration of emerging trends in NLP and Large Language Models. Discussion on the potential impact of future advancements in AI and biomedical engineering.

Text Books / Reference Books:

1. Dan Jurafsky, James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition," 3rd Edition, Pearson, 2019
2. Lane, Howard, Hapke, "Natural Language Processing in Action," 1st Edition, Manning Publications, 2019
3. Rajalingappaa Shanmugamani, "Hands-On Natural Language Processing with Python: A practical guide to applying deep learning architectures to your NLP applications," 1st Edition, Packt Publishing, 2018
4. Alexander Rush, "Transformers in Natural Language Processing," 1st Edition, O'Reilly Media, 2021

CO-PO mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	1	1	1	3	-	-	2	2	-	2	1	-	-
CO2	3	2	3	3	2	3	-	2	2	2	-	2	3	3	3
CO3	2	2	2	2	1	3	-	1	2	2	-	2	2	1	2
CO4	3	3	3	3	2	3	-	2	2	2	-	2	3	3	3

Course Objectives:

- Understand the fundamental concepts and differences between computer architecture and organization, providing a comprehensive overview of von Neumann machine organization and its construction from Boolean logic.
- Master the representation of integers and real numbers, algorithms for common arithmetic operations, memory operations, instruction formats, execution cycles, and addressing modes.
- Gain proficiency in memory system organization, including memory hierarchy, main memory, cache memory, and virtual memory, as well as I/O organization and external storage systems.
- Learn the design principles of control units, and the organization of central processing units (CPU).

Course Outcomes:

After completing this course, students should be able to

CO1: Build basic digital logic circuits for CPU components like adders and flip-flops.

CO2: Interpret machine instructions to understand how programs execute on a computer.

CO3: Evaluate memory hierarchy designs and I/O communication protocols to optimize data access and peripheral interaction.

CO4: Design microprogrammed control units and analyze architectural trends like pipelining to maximize CPU performance and efficiency.

Syllabus :

Unit 1: Overview of Computer Architecture and Organization: Contrast between computer architecture and organization, Fundamentals of computer architecture, Organization of von Neumann machine, Boolean Algebra, Logic Gates, K Map, Combinational Circuits (Adders, Multiplexers, ALU), Sequential Circuits - Flipflops, Counters, Registers.

Unit 2: Computer Arithmetic and Machine Instruction: Representation of integers and real numbers algorithm for carrying out common integer and floating-point operations, Memory Locations and Addresses, Memory operations, Instruction format, execution cycle, Instruction types and addressing modes.

Unit 3: Memory System Organization and Architecture: Memory system hierarchy, main memory organization, cache memory, virtual memory. I/O organization: Bus control, Serial I/O (study of Asynchronous and synchronous modes), Parallel Data transfer: (Program controlled: Asynchronous, synchronous & Interrupt driven modes, DMA mode, interrupt controller and DMA controller), Buses Device subsystem, External storage system, RAID architecture.

Unit 4 Design of control unit**,** microprogrammed Control unit. Organization of CPU: Single vs multiple data path ISA Control unit Instruction, pipelining, Trends in computer architecture: CISC, RISC, VLIW, Pipelining (stages, hazards).

Textbooks & References

1. V. C. Hamacher, Z. G. Veranesic, and S. G. Zaky, *Computer Organization*, Tata McGraw Hill
2. William Stallings, Computer Organization and Architecture -– Designing for Performance, Pearson Education
3. J. P. Hayes, *Computer Architecture and Organisation*, McGraw Hill
4. D.A. Pattersen and J. L. Hennesy, Computer Architecture- A quantitative Approach, Morgan Kaufman

CO-PO Mapping

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	2	1	-	-	2	-	2	2	-	2	3	1	2
CO2	3	3	2	-	-	-	2	-	2	2	-	2	3	1	2
CO3	3	3	2	-	-	-	2	-	2	2	-	2	3	1	2
CO4	3	3	2	1	-	-	2	-	2	2	-	2	3	1	3

22ADM101 – Foundations of Indian heritage Credits: 2 Weekly: 2-0-1

Course Objectives:

- The course is designed as an introductory guide to the variegated dimensions of Indian cultural and intellectual heritage, to enable students to obtain a synoptic view of the grandiose achievements of India in diverse fields.
- It will equip students with concrete knowledge of their country and the mind of its people and instil in them some of the great values of Indian culture.

Course Outcomes:

After completing this course, students should be able to

CO1: Be introduced to the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma's life and vision of holistic education.

CO2: Understand the foundational concepts of Indian civilization like puruśārtha-s, law of karma and varṇāśrama.

CO3: Gain a positive appreciation of Indian culture, traditions, customs and practices.

CO4: Imbibe spirit of living in harmony with nature, and principles and practices of Yoga.

CO5: Get guidelines for healthy and happy living from the great spiritual masters

Syllabus:

Unit 1: Introduction to Indian culture; Understanding the cultural ethos of Amrita Vishwa Vidyapeetham; Amma's life and vision of holistic education.

Unit 2: Goals of Life – Purusharthas; Introduction to Varnasrama Dharma; Law of Karma; Practices for Happiness.

Unit 3: Symbols of Indian Culture; Festivals of India; Living in Harmony with Nature; Relevance of Epics in Modern Era; Lessons from Ramayana; Life and Work of Great Seers of India.

Reference Book(s) :

1. The Eternal Truth (A compilation of Amma's teachings on Indian Culture)
2. Eternal Values for a Changing Society. Swami Ranganathananda. BharatiyaVidyaBhavan.
3. Awaken Children (Dialogues with Mata Amritanandamayi) Volumes 1 to 9
4. My India, India Eternal. Swami Vivekananda. Ramakrishna Mission.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	2	-	3	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	3	2	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-

Course Objective

· Assist students in inculcating Soft Skills and developing a strong personality
· Help them improve their presentation skills
· Support them in developing their problem solving and reasoning skills
· Facilitate the enhancement of their communication skills

Course Outcomes

After completing this course, students will be able to
CO1 Soft Skills: To develop greater morale and positive attitude to face, analyse, and manage emotions in real life situations, like placement process.
CO2 Soft Skills: To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews.
CO3 Aptitude: To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.
CO4 Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis.
CO5 Verbal: To infer the meaning of words and use them in the right context. To have a better understanding of the basics of English grammar and apply them effectively.
CO6 Verbal: To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively.

Syllabus

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. New-age challenges and distractions. Learning to benefit from constructive criticisms and feedback, Need for change in mindset and up-skilling to keep oneself competent in the professional world.
Managing Self: Knowing oneself, Self-perception, Importance of positive attitude, Building and displaying confidence, Avoiding being overconfident, Managing emotions, stress, fear. Developing Resilience and handling failures. Self-motivation, Self-learning, and continuous knowledge up-gradation / Life-long learning. Personal productivity - Goal setting and its importance in career planning, Self-discipline, Importance of values, ethics and integrity, Universal Human Values.
Aptitude
Problem Solving I
Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.
Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.
Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.
Averages: Basics, and Weighted Average.
Data Interpretation: Tables, Bar Diagrams, Venn Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, Network Diagrams and other forms of data representation.
Verbal
Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misused words, commonly confused words and wrong form of words in English.
Grammar (Basic): Help students learn the usage of structural words and facilitate students to identify errors and correct them.
Reasoning: Stress the importance of understanding the relationship between words through analogy questions.
Speaking Skills: Make students conscious of the relevance of effective communication in today's world through various individual speaking activities.

Text Books / References

Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa

Vidyapeetham.
Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K
Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
The hard truth about Soft Skills, by Amazon Publication.
Verbal Skills Activity Book, CIR, AVVP
English Grammar & Composition, Wren & Martin
Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
Cracking the New GRE 2012
Kaplan's – GRE Comprehensive Programme
Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
How to Prepare for Data Interpretation for the CAT, Arun Sharma.

CO-PO Mapping

PO/ PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO															
CO 1	-	-	-	-	-	-	-	2	3	3	-	3	-	-	-
CO 2	-	-	-	-	-	-	-	-	2	3	-	3	-	-	-
CO 3	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO 6	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-

Micro-credential courses: Set 3 **Credits: 4** **Weekly: 3-0-2**

Items listed below (A to D) may change owing to temporal mandates and developments.

A. 24AIM231 - Signal Processing with LA & Optimization and Probability theory 3 0 2 4

CO: The student should be able to apply mathematical principles for signal processing.

Least Squares with Examples in Signal Processing
Polynomial approximation, Linear prediction, Smoothing, Deconvolution, System identification, Estimating missing data, Speech de-clipping

References:

1. https://eeweb.engineering.nyu.edu/iselesni/software/index.html
2. https://eeweb.engineering.nyu.edu/iselesni/lecture_notes/least_squares/index.html
3. https://eeweb.engineering.nyu.edu/iselesni/lecture_notes/sparsity_intro/sparse_SP_intro.pdf
4. https://eeweb.engineering.nyu.edu/iselesni/lecture_notes/TVDmm/index.html

B. 24AIM232 - Introduction to Signal Acquisition systems: ECG, EEG: 3 0 2 4

CO: The student should be able to analyze ECG and EEG signals.

What is ECG?. The Electrical and Mechanical Sequence of a Heartbeat, ECG Activity
Components of the ECG, Leads, Common Applications for ECG Measurement, Preparing for an ECG Recording
ECG Lead Configurations, Hardware Setup - Hardware required to record ECG
Hardware Components - Wireless Methods. Software Setup: BIOPAC Data Acquisition and Analysis Software
The Introductory Guide to EEG: Types of Brainwaves that EEG Measures
EEG Caps and EEG Headsets, Open BCI kits

References:
1. https://www.biopac.com/wp-content/uploads/ECG-Guide.pdf
2. https://docs.openbci.com/AddOns/Headwear/HeadBand

C. 24AIM233 – Brain-computer interface devices 3 0 2 4

CO: The student should be able to demonstrate and apply the BCI to arrive at effective outcomes.

Examples of BCI (invasive/non-invasive), (1) signal acquisition, (2) feature extraction, (3) feature translation, and (4) device output. Developing a simple BCI.

References

1. https://en.wikipedia.org/wiki/Brain%E2%80%93computer_interface
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3497935/
3. https://www.youtube.com/watch?v=LoGBCsFPNzU

D. 24AIM234 - Introduction to Biomechanics: 3 0 2 4

CO: The student should be able to demonstrate a clear understanding of human biomechanics to design prosthetic devices.

Biomechanics & Design, Musculoskeletal system, Body mass segments, Case study in biomechanics, Models of human proprioception

References

1. https://ocw.tudelft.nl/wp-content/uploads/H-L-2_Introduction_to_Biomechanics.pdf
2. Duane Knudson, Fundamentals of Biomechanics
3. http://www.profedf.ufpr.br/rodackibiomecanica_arquivos/Books/Duane%20Knudson-%20Fundamentals%20of%20Biomechanics%202ed.pdf

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
A	3	3	3	3	1	-	-	-	2	2	-	2	2	1	2
B	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
C	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
D	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2

Semester IV

23MAT214 Mathematics for Intelligent Systems 4 Credits: 3 Weekly: 2-0-2

Course Objectives:

- Provide students with advanced knowledge and skills in optimization, statistical estimation theory, and quantum computing.
- Understand and analyze special matrices used in various areas of signal processing and data analysis.
- Learn optimization techniques for convex and non-convex problems, and their application to machine learning problems.
- Introduce statistical estimation theory and hypothesis testing, and their relevance to data analysis.
- Provide an overview of quantum computing and its potential applications in various field.

Course Outcomes:

After completing this course, students should be able to:

CO1: Apply proximal algorithms, augmented Lagrangian, and ADMM to solve convex and non-convex optimization problems.

CO2: Develop optimization algorithms used in neural networks.

CO3: Apply statistical estimation theory and hypothesis testing to data analysis applications.

CO4: Apply quantum computing concepts to solve problems in various fields including cryptography and optimization.

SYLLABUS:

Unit 1: Special Matrices: Fourier Transform, discrete and Continuous, Shift matrices and Circulant matrices, The Kronecker product, Toeplitz matrices and shift invariant filters, Hankel matrices, DMD and need of Hankelization - Importance of Hankelization – DMD and its variants - Linear algebra for AI

Unit 2: Matrix splitting and Proximal algorithms - Augmented Lagrangian- Introduction to ADMM, ADMM for LP and QP - Optimization methods for Neural Networks: Gradient Descent, Stochastic gradient descent-loss functions and learning functions

Unit 3: Basics of statistical estimation theory and testing of hypothesis.

Unit 4: Introduction to quantum computing- Bells's circuit, Superdense coding, Quantum teleportation. Programming using Qiskit, Matlab.

Text Books / Reference Books

1. Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.
2. Gilbert Strang, "Differential Equations and Linear Algebra Wellesley", Cambridge press, 2018.
3. Stephen Boyd and, Lieven Vandenberghe, "Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares", Cambridge University Press, 2018
4. Bernhardt, Chris. Quantum computing for everyone. Mit Press, 2019. (From pages 71 to 140).
5. Larry Wasserman. All of Statistics: A Concise Course in Statistical Inference (Springer Texts in Statistics, 2003).

CO-PO Mapping

PO															

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	3	-	-	-	2	2	-	2	2	2	-
CO2	3	3	3	2	3	-	-	-	2	2	-	2	2	2	-
CO3	3	2	2	2	3	-	-	-	2	2	-	2	2	1	-
CO4	3	3	3	3	3	-	-	-	2	2	-	2	2	1	-

24AIM211 - Machine learning for cheminformatics and bioinformatics Credits: 3 Weekly: 2-0-2

Course Objectives:

- Acquire proficiency in accessing and utilizing molecular structure databases such as Cambridge Structural Database (CSD) and Protein Data Bank (PDB) for biomolecular research.
- Develop skills in molecular modeling, including the creation and visualization of 3D models using tools like Gauss View, Avogadro, and Chemcraft.
- Gain an understanding of molecular interactions through the study of energy potentials, force-fields, and molecular mechanics, and apply this knowledge to model solvents and calculate thermodynamic properties.
- Explore the principles of drug design, covering the drug discovery pipeline, Lipinski's Rules of 5, ADMET models, drug resistance, and drug delivery systems, along with hands-on experience in molecular docking.
- Learn about the application of artificial intelligence (AI) and machine learning (ML) in drug and materials design, including linear free energy relationships, structure-activity relationships, virtual high-throughput screening, and various machine learning models.
- Introduce fundamental concepts in bioinformatics, including phylogenetic trees, homology modelling, sequence alignment, BLAST, multiple sequence alignment, and RNA secondary structure prediction.

Course Outcomes:

After completing this course, students should be able to

CO1: Navigate and utilize molecular structure databases for biomolecular research.

CO2: Create and visualize 3D molecular models using tools like Gauss View, Avogadro, and Chemcraft.

CO3: Apply the principles of molecular mechanics to model solvents, perform energy minimization, and calculate thermodynamic properties.

CO4: Understand and apply drug design principles, including molecular docking techniques, drug discovery pipeline, and pharmacophore modeling.

CO5: Apply AI and ML techniques to drug and materials design, using various models such as random forests, PLS, SVM, and neural networks.

CO6: Perform basic bioinformatics analyses, including phylogenetic analysis, homology modeling, sequence alignment, BLAST, multiple sequence alignment, and RNA secondary structure prediction.

Syllabus:

Unit 1: Molecular Structure Databases: Cambridge Structural Database (CSD), Protein Data Bank (PDB), File format and information in PDB and CSD databases; Molecular Modelling: Molecular Graphics, 3-D Models of Organics and Biomolecules, Potential Energy Surfaces; Case Study: Visualization of 3D Models with Gauss View/Avogadro/Chemcraft

Unit 2: Molecular Interactions: Energy potentials in Molecular Modelling (Force-Fields), Bonded Terms in Molecular Mechanics, Non-bonded Terms, Effective Pair Potential, Type of Molecular Interactions in molecular modelling, Applications of Molecular Modelling (Hands-on): Generating Energy parameters for small organic compounds, Modelling of solvents, Energy minimization and Calculating Thermodynamics Properties using Molecular Mechanics; Case Study: Force-Field Parametrization of simple Organic Molecules

Unit 3: The Principles of Drug Design: The Drug Discovery Pipeline and Costs of Drug Discovery, Lipinski's Rules of 5, Drug Metabolism, Toxicity and Side Effects, ADMET (Absorption, Distribution, Metabolism, Excretion, Toxicity) Models, Drug resistance and promiscuity, Drug Delivery systems, Pharmacophore Modelling and alignment, Lead Optimization, Ligand-Based and Structure-Based Design; Molecular Docking, Introduction, Scoring Functions, Applications of Docking; Case Study: Setting up a Molecular Docking for a simple biomolecule.

Unit 4: AI/ML in Drug and Materials Design: Linear Free Energy Relationships, Structure-Activity Relationships and the Similarity Principle, Virtual High-throughput Screening, Feature selection - Genetic Algorithms, Model Validation, Case Study: Modeling with random forests, PLS, SVM and Neural Networks.

Unit 5: Introduction to Bioinformatics: Phylogenetic trees; Homology modelling, Sequence alignment, global and local alignments; BLAST and Protein BLAST; Multiple Sequence Alignment with Clustal Omega; RNA Secondary Structure Prediction with mfold; naïve Bayesian models.

Textbooks & References:

1. Leach, A.R. *Molecular Modelling Principles and Applications* (Prentice Hall, Edition 2, 2001).
2. Thomas Engel, Johann Gasteiger, *Chemoinformatics: Basic Concepts and Methods* (Wiley-VCH, 2018)
3. Jürgen Bajorath (Editor), *Chemoinformatics and Computational Chemical Biology* (Methods in Molecular Biology) (Humana Press, 2004)
4. Andrew R. & Leach, Valerie Gillet, *An Introduction to Chemoinformatics* (Springer International, New Delhi, 2009)
5. N. Sukumar, Harishchander Anandaram and Pratiti Bhadra, "*Computational Drug Discovery – A Primer*" (Ion Cures Press, 2023). ISBN: 979-8850083663
6. John L. Lamattina, *Drug Truths: Dispelling the Myths about Pharma R&D* (John Wiley, Hoboken, NJ, 2008)
7. Barry Werth, *The Billion Dollar Molecule: One Company's Quest for the Perfect Drug* (Simon & Schuster, 1995) *Bioinformatics for Dummies*.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	3	-	-	-	-	-	-	-	3	2	-
CO2	-	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO3	-	2	2	-	2	-	-	-	-	-	-	-	-	2	-
CO4	3	2	2	3	-	1	2	2	2	1	2	-	3	3	-
CO5	3	2	-	2	3	-	-	-	-	-	-	-	3	3	-
CO6	-	2	-	-	2	-	-	-	-	2	-	-	3	3	-

Course Objectives:

- Understand the fundamental concepts and mechanisms contributing to the balance and normalcy of biological functions in living organisms.
- Gain a comprehensive understanding of immunology, focusing on the differentiation between self and non-self, and its implications in maintaining health.
- Explore and analyze the cascadic or cataclysmic events and effects leading to aging and pathology, considering various factors such as genetic, germs, deficiency, psychological, accidental/environmental, and murburn.
- Familiarize with different types and schools of therapy, and establish a solid foundation in modern medicine and pharmacology.
- Evaluate the feasibility of a holistic approach to maintenance and disruption of life, understanding its potential applications and limitations.

Course Outcomes:

After completing this course, students should be able to

CO1: Demonstrate an understanding of the intricacies of maintaining balance and normalcy in biological functions.

CO2: List the known fundamental principles of immunology and its role in preserving health.

CO3: Analyze the origins of aging and pathology, considering diverse factors contributing to health challenges.

CO4: Differentiate between various types and schools of therapy, establishing a strong foundation in modern medicine and pharmacology.

CO5: Critically assess the feasibility and potential applications of a holistic approach to maintenance and disruption of life.

Syllabus:

Unit 1: Balance/normalcy of function: indices, normal and average values,

Unit 2: Immunology: fundamental details of differentiation of self and non-self

Unit 3: Cascadic or cataclysmic events/effects, Origins of aging and pathology (Genetic, germs, deficiency, psychological, accidental/environmental, murburn, etc.)

Unit4: Types & schools of therapy; foundations of modern medicine and pharmacology, pharmacokinetics and pharmacodynamics, feasibility of “holistic approach”?

References/books

1. John Firth, Christopher Conlon, Timothy Cox. Oxford textbook of medicine (2020).
2.
3. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt. Roitt’s Essential Immunology. Wiley-Blackwell (20116), ISBN: 978-1-118-41577-1
4. Alain Galbraith. Fundamentals of pharmacology (Pearson Education, 2007)
5. Robbins and Cotran Pathologic Basis of Disease (Two Vol Set), 10e, South Asia Edition by Manoj Singh and Vinay Kumar.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO3	PSO4
CO1	3	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO2	-	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO3	-	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO4	-	2	-	-	-	-	-	-	2	2	-	2	3	3	3
CO5	-	2	-	-	-	-	-	-	2	2	-	2	3	3	3

24A1M213 Introduction to biomaterials & engineering Credits: 3 Weekly: 2-0-2

Course Objectives:

- Develop an understanding of molecular bonds, crystal structures, and defects in biomaterials.
- Understand diffusion, solidification, and phase diagrams in biomaterials processing.
- Explore strength, plastic deformation, grain dynamics, and fracture in biomaterials.
- Evaluate fatigue, crack growth, creep, and corrosion in the context of biomaterials.
- Examine the structure, properties, and applications of polymers in biomaterials.

Course Outcomes:

After completing this course, students should be able to
CO1: Analyze biomaterials using molecular and crystal-level concepts.
CO2: Assess biomaterials' mechanical behaviour, fracture mechanisms and processing factors affecting biomaterials.
CO3: Predict and manage fatigue, crack growth, creep, and corrosion in biomaterials.
CO4: Characterize polymers and assess their applications in biomaterials.
CO5: Delineate the principles of biomaterial stability.

Syllabus:

Unit 1: Bonds and crystal structure; defects in crystalline solids; diffusion; solidification; phase diagram.
Unit 2: Strength of materials; plastic deformation; recrystallization; grain growth; fracture of materials.
Unit 3: Fatigue life and fatigue crack growth; creep; corrosion; structure and properties of polymers; analytical and testing, techniques.
Unit 4: Introduction to functional materials; structure and properties of biological materials; materials in biomedical applications and their stability.

References:

1. An introduction to biomaterials engineering (biomedical engineering) by Jeffrey Hollinger, CRC Press, 2011.
2. http://www.freeengineeringbooks.com/BioMedical/Biomaterials-Books.php
3. http://www.issp.ac.ru/ebooks/books/open/Biomaterials_Science_and_Engineering.pdf

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	2	1	-	-	-	2	2	-	2	2	1	1
CO2	3	3	3	2	1	-	-	-	2	2	-	2	2	1	1
CO3	3	3	3	2	1	-	-	-	2	2	-	2	2	1	1
CO4	3	3	3	2	1	-	-	-	2	2	-	2	2	1	1
CO5	3	3	3	2	1	-	-	-	2	2	-	2	2	1	1

Course Objectives:

- Impart know-how of the fundamental services provided by operating systems and their role in hardware protection.
- Provide details of process and processor management, including process scheduling, inter-process communication, and CPU scheduling algorithms.
- Disseminate knowledge of process synchronization, deadlock handling, memory management, and file systems in operating systems.
- Exposure to data communications, network models, digital transmission, and transport layer protocols.
- Enable students to understand network layer protocols, addressing, routing algorithms, and link layer concepts, including error detection, correction, and multiple access protocols.

Course Outcomes:

After completing this course, students should be able to

CO1: Apply operating system principles to manage processes, memory, and file systems effectively.

CO2: Design and analyze network protocols, considering various layers and communication aspects.

CO3: Implement and troubleshoot data communication and network-related issues.

CO4: Analyze and optimize network performance and address challenges in operating systems.

CO5: Understand and implement various networking concepts, including routing, addressing, and link-layer protocols.

Syllabus:

Unit 1 : Operating systems Services: Overview – hardware protection – operating systems services – system calls – system structure – virtual machines. Process and Processor management: Process concepts – process scheduling – operations on process – cooperating process – inter-process communication – multi threading models – threading issues – thread types – CPU scheduling – scheduling algorithms.

Unit 2 : Process synchronization: critical section problem – synchronization hardware – semaphores – classical problems of synchronization – critical regions – monitors – deadlocks – deadlock characterization – methods of handling deadlocks – deadlock prevention – avoidance – detection and recovery. Memory management – swapping – contiguous memory allocation. Paging and segmentation – segmentation with paging – virtual memory – demand paging – process creation – page replacement – thrashing. File management: File systems: directory structure – directory implementation – disk scheduling. Case study: threading concepts in operating systems, kernel structures.

Unit 3 : Introduction:-Data communications- Networks- The Internet - Protocols and standards. Network Models:- layered tasks , TCP/IP protocol suite, Addressing. Data and signals:- Analog and digital ,data rate limits, performance. Digital transmission: - digital –to digital conversion, Analog-to-digital conversion, transmission modes.

Unit 4 : Transport layer - Connection Oriented Transport - TCP, Principles of Congestion Control, TCP Congestion Control. Introduction Network Layer: Virtual Circuit and Datagram Networks, Inside a Router, The Internet Protocol (IP) - Forwarding and Addressing in the Internet, Routing Algorithms, Routing in the Internet, Broadcast and Multicast Routing.

Unit 5 : The Link Layer and Local Area Networks - Introduction and Services, Error-Detection and Correction Techniques, Multiple Access Protocols - Link-Layer Addressing, Ethernet, Link-Layer Switches– Case Study: Virtualization and data center Networking.

References

1. Silberschatz A, Gagne G, Galvin PB. Operating system concepts. Tenth Edition, John Wiley and Sons; 2018
2. Kurose J F and Ross K W. Computer Networking: A Top-Down Approach. Seventh Edition, Pearson Press, 2017.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	1	-	-	-	2	2	-	2	3	1	2
CO2	3	2	3	3	1	-	-	-	2	2	-	2	3	1	2
CO3	3	2	2	3	1	-	-	-	2	2	-	2	3	1	2
CO4	3	3	2	3	1	-	-	-	2	2	-	2	3	1	2
CO5	3	2	2	3	1	-	-	-	2	2	-	2	3	1	2

Course Objectives:

- Understand the principles and sources of science and technology in ancient India.
- Analyze the evolution of astronomy and mathematics from the Neolithic era to the Kerala school.
- Evaluate the contributions of Jain, Buddhist, and Siddhantic periods to Indian science.
- Discuss the legacy of Indian science, encompassing ancient times to modern contributions by figures like S. Ramanujan.

Course Outcomes:

After completing this course, students should be able to:

CO1: Appreciate the principles and sources of science and technology in ancient India.

CO2: Understand the evolution of astronomy and mathematics during the Neolithic, Indus Civilization, Vedic literature, and Vedanga Jyotisha periods.

CO3: Analyze the contributions of Jain and Buddhist literature to astronomy and mathematics.

CO4: Evaluate the Siddhantic period, focusing on Aryabhata, Brahmagupta, Bhaskara II, and the Kerala school of mathematics.

CO5: Discuss the legacy of Indian science, exploring its continuity from ancient times to recent scientists like S. Ramanujan.

Syllabus:

Unit 1: General introduction: principles followed and sources-Astronomy & mathematics from the Neolithic to the Indus Civilization-Astronomy & mathematics in Vedic literature-Vedanga Jyotisha and the first Indian calendars-Shulba Sutras and the foundations of Indian geometry.

Unit 2: Astronomy & mathematics in Jain and Buddhist literature-The transition to the Siddhantic period-Aryabhata and his time-The Aryabhatiya: concepts, content, commentaries-Brahmagupta and his advances-Other great Siddhantic savants-Bhaskara II and his advances.

Unit 3: The Kerala school of mathematics-The Kerala school of astronomy-Did Indian science die out? - Overview of recent Indian scientists, from S. Ramanujan Onward-Conclusion: assessment and discussion.

Textbook(s)

1. S. Balachandra Rao, Indian Mathematics and Astronomy: Some Landmarks.

Reference(s)

1. IFIH's interactive multimedia DVD on Science & Technology in Ancient India.

CO-PO Mapping

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	-	-	-	2	-	-	-	-	-	-	1	-	
CO2	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	1	-	1	-	-	-	-	-	-	-	-	-	1
CO4	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	3	-	3	-	-	-	-	-	-	-

22ADM111	GLIMPSES OF GLORIOUS INDIA	L-T-P-C:2-0-1-2

Course Objectives

The course aims at introducing Bhārath in nutshell to the student, which includes the sources of Indian thoughts, eminent personalities who shaped various disciplines, India's significant contribution to the man kind, the current stature of Indian in the geopolitics and Indian approach to science and ecology.

Course Outcomes

CO1: Will be able to recognise the call of Upanishads and outstanding personalities for confronting the wicked in the real world while admiring the valour, pursuit and divinity in both classical and historical female characters of India.

CO2: Will get introduced to Acharya Chanakya, his works, and his views on polity and nation to find synchrony between public and personal life, alongside understanding India's cultural nuances and uniqueness concerning the comprehension of God across major global communities.

CO3: Will be able to appreciate Bhagavad Gita as the source of the Indian worldview through the various Yogic lessons enshrined in it, making it one of India's numerous soft powers, and also understand the faith-oriented mechanism of preserving nature.

CO4: Will be informed about the enormous contribution of Indian civilisation over two and a half millennia to humanity and develop awareness about India's approach toward science, devoid of dogmas and rooted in humanism.

CO-PO- Mapping

)/PSO)	)1	)2	)3	)4	)5	)6	)7	)8	)9	)10	)11	)12	O1	O2
)1			1	2				2						
)2	2	1				1		3	1					
)3	2		1	2	1	1		3						
)4	2			3				3	2					

Syllabus

Face the Brutes, Role of Women in India, Acharya Chanakya, God and Iswara, Bhagavad Gita: From Soldier to Samsarin to Sadhaka, Lessons of Yoga from Bhagavad Gita, Indian Soft powers, Preserving Nature through Faith, Ancient Indian Cultures (Class Activity), Practical Vedanta, To the World from India, Indian Approach to Science.

Textbook(s)

"Glimpses of Glorious India", In house publication (In print).

Reference(s)

The Kautilya Arthashastra by Chankaya – Translation with critical and explanatory note by R P Kangle – Motilal Banarasidass Publishers- 1972.

Chanakya Neeti – Strategies for success – Radhakrishnan pillai – Jaico Publishing house -2020.

Universal Message of the Bhagavad Gita: An exposition of the Gita in the Light of Modern Thought and Modern Needs. - Swami Ranganathananda, Advaita Ashrama Belur Math, 2000.

A Concise History Of Science In India – D M Bose, S N Sen, B V Subbarayappa,The Indian National Science Academy 1971.

Indian Culture and India's Future – Michel Danino - D.K. Printworld (P) Ltd -2011.

Evaluation Pattern: 50:50

ssessment	ternal	d Semester
riodical 1	15%	
riodical 2	15%	
Continuous Assessment (CA)	20%	

d Semester		50%

*CA includes Quizzes and Tutorials

23LSE211 Life Skills for Engineers II Credits: 2 Weekly: 1-0-2

Course Objectives

- Assist students in inculcating Soft Skills and developing a strong personality
- Help them improve their presentation skills
- Aid them in developing their problem solving and reasoning skills
- Facilitate them in improving the effectiveness of their communication.

Course Outcomes

After completing this course, students will be able to

CO1 Soft Skills: To develop greater morale and positive attitude to face, analyse, and manage emotions in real life situations, like placement process.

CO2 Soft Skills: To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews.

CO3 Aptitude: To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.

CO4 Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis.

CO5 Verbal: To learn to use more appropriate words in the given context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.

CO6 Verbal: To be able to read texts critically and arrive at/ predict logical conclusions. To learn to organize speech and incorporate feedback in order to convey ideas with better clarity.

Syllabus

Soft Skills

Communication: Process, Language Fluency, Non-verbal, Active listening. Assertiveness vs. aggressiveness. Barriers in communication. Digital communication Presentations: Need, importance, preparations, research and content development, structuring and ensuring flow of the presentation. Ways and means of making an effective presentation: Understanding and connecting with the audience – using storytelling technique, managing time, appropriate language, gestures, posture, facial expressions, tones, intonations and grooming. Importance of practice to make an impactful presentation.

Aptitude

Problem Solving II

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages. Logarithms, Inequalities and Modulus: Basics

Time and Work: Basics, Pipes & Cistern, and Work Equivalence.

Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.

Logical Reasoning: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives.

Verbal

Vocabulary: Aid students learn to use their vocabulary to complete the given sentences with the right words. Usage of more appropriate words in different contexts is emphasized.

Grammar (Basic-intermediate): Help students master usage of grammatical forms and enable students to identify errors and correct them.

Reasoning: Emphasize the importance of avoiding the gap (assumption) in arguments/ statements/ communication.

Reading Comprehension (Basics): Introduce students to smart reading techniques and help them understand different tones in comprehension passages.

Speaking Skills: Make students be aware of the importance of impactful communication through individual speaking activities in class.

Writing Skills: Introduce formal written communication and keep the students informed about the etiquette of email writing.

CO-PO Mapping

PO/ PSO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO1 2	PSO 1	PSO2	PSO3
CO															
CO 1								2	3	3		3			
CO 2									2	3		3			
CO 3		3		2											
CO 4		3		2											
CO 5										3		3			
CO 6									3	3		3			

Items listed below (A to D) may change owing to temporal mandates and developments.

A. 24AIM241 - Introduction to Programming on FPGAs 3 0 2 4

CO: The student should be able to implement circuits using Verilog in FPGA.

Architectures of commercially available high-capacity field-programmable devices (FPDs) SimplePLDs (SPLDs), Complex PLDs (CPLDs) and Field-Programmable Gate Arrays (FPGAs Hardware Description Languages

Verilog - Clocks and Procedural Assignments - Finite State Machine (FSM) - Verilog Modules and Parameters. Verilog Testbenches and Simulation - Memory and Block RAM - Phase-Locked Loop (PLL) and Glitches

Metastability and FIFO

References:

1. http://ece-research.unm.edu/jimp/415/contrib/toronto_fpga_tut.pdf
2. https://www.csl.cornell.edu/courses/ece5745/handouts/ece4750-tut3-verilog.pdf
3. Complex Digital ASIC Design: https://www.csl.cornell.edu/courses/ece5745/
4. Shawn Hymel: Introduction to FPGAs https://www.youtube.com/watch?v=lLg1AgA2Xoo&list=PLEBQazB0HUyT1WmMONxRZn9NmQ_9CIKhb
5. https://github.com/ShawnHymel/introduction-to-fpga
6. Nandland - FPGA101 - https://nandland.com/fpga-101/

B. 24AIM242 - Introduction to web programming 3 0 2 4

CO: The student should be able to design robust websites using HTML, CSS and Javascript.

Basic Web Programming

• HTML • CSS • JavaScript

References:

1. https://www.halvorsen.blog/documents/programming/web/resources/Introduction%20to%20Web%20Programming.pdf
2. Keith Peters, Playing with Chaos: Programming Micro-credentials and Strange Attractors in JavaScript

C. 24AIM243 - Introduction to Interfacing Devices to Computers (Standards and Protocols) 3 0 2 4

CO: The student should be able to interface the different components of a modern computer system.

The typical personal computer system Peripherals: Memory, a hard disk drive, a keyboard, mouse, wireless and wired network interfaces, USB ports, sound and video system components, usually a modem, perhaps parallel, FireWire, and serial ports, and a monitor

Protocols: Serial devices, Protocols, Signal/data/port specifications for the devices, Universal Synchronous/Asynchronous Receiver Transmitter (USART), Serial Peripheral Interface (SPI), Universal Serial Bus (USB), Wi-Fi- WiMax- Insteon

References:

1. Serial Communication Protocols and Standards RS232/485, UART/USART, SPI, USB, INSTEON, Wi-Fi and WiMAX
2. COMPUTER PERIPHERALS http://seu1.org/files/level3/2-IT110/book/ch10.pdf

D. 24AIM244 - Advanced Programming with FPGAs 3 0 2 4

CO: The student should be able to interface hardware to FPGA.

FPGA Hardware Interfacing - UART - I2C - SPI - PWM - SD Card - HDMI - Flash Memory - Servo Motors
RISC-V Softcore Processor - RISC-V Peripherals
FPGA Graphics - DSP with FPGAs

References:

1. Orhan Ghasi, State Machines using VHDL: FPGA Implementation of Serial Communication and Display Protocols
2. FPGA4FUN - https://www.fpga4fun.com/
3. FemtoRV - RiscV tutorial - https://github.com/BrunoLevy/learn-fpga/tree/master/FemtoRV/
4. Project F - FPGA Graphics / DSP - https://projectf.io/tutorials/

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
A	3	3	3	3	1	-	-	-	2	2	-	2	2	1	2
B	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
C	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
D	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2

Semester v

24AIM301 – Signal & Image Processing **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To provide students information about advanced biomedical signal processing techniques.
- To afford the ability to implement and apply techniques for biomedical signal processing and analysis.
- To impart the basics of digital image processing techniques.
- To impart an understanding on the application of digital image processing techniques on medical image processing.
- To enable the students to implement and apply image processing techniques for image quality improvement and analysis of medical images.

Course Outcomes:

After completing this course, students should be able to
CO1: Analyze time and frequency properties of signals using Fourier and Wavelet transforms
CO2: Design filters for processing of signals
CO3: Perform data driven representation of signals using PCA and ICA
CO4: Carry out digital image processing, in various stages (sampling, segmentation, classification)
CO5: Demonstrate competence in image compression and feature extraction

Syllabus:

Unit-1: Review of Biomedical Signals and Systems Introduction to Biomedical signals and characteristics of dynamic biomedical signals, Noises, Filters- IIR and FIR filters, Spectrum – power spectral density function, cross-spectral density and coherence function, cestrum and homomorphic filtering.

Unit-2: Time-Frequency Analysis – Fourier transform, wavelet transform, applications of wavelets, Multivariate analysis- PCA and ICA in biomedical signal analysis.

Unit-3: Fundamentals of Digital Image Processing Components of an image processing system, Digital image representation, Digital images, Image sampling and quantization, Image Enhancement and Segmentation- Segmentation based on dissimilarities (point, line and edges), region-based segmentation (thresholding, region growing, splitting and merging, active contours, clustering, Applications in medical image segmentation, performance evaluation of segmentation algorithms. Feature Extraction and Classification of Medical Images Boundary preprocessing and features, region-based features, texture analysis, principal components, pattern classification and performance evaluation.

Unit-4: Image Compression Coding Redundancy, Spatial and Temporal Redundancy, Irrelevant Information, Measuring Image Information, Shannon's First Theorem, Fidelity Criteria, Image Compression Models, The Encoding or Compression Process, lossy and lossless image compression techniques.

Text Books / References

1. 'Digital Image Processing using MATLAB', Rafael C. Gonzalez, Richard E. Woods and Steven Eddins, Pearson Education Inc., 2011.
2. 'Digital Image Processing', William K. Pratt, John Wiley, New York, 2002.
3. 'Digital Signal and Image Processing The Sparse Way', K.P.Soman and R. Ramanathan,Cengage Learning Pvt. Ltd, 2016.
4. Cohen, A. (1986). Biomedical Signal Processing: Volume 1 and 2. CRC Press.
5. Rangayyan, R. M. (2015). Biomedical Signal Analysis. Germany: Wiley.
6. Tompkins, W. J. (1993). Biomedical Digital Signal Processing. United Kingdom: Prentice Hall.

7. Rao, R. M. (1998). Wavelet Transforms: Introduction to Theory and Applications. India: Pearson Education.
8. Biomedical Signal Processing and Control, Journal (ISSN: 1746-8094), Elsevier.
9. Woods, R. E., Gonzalez, R. C. (2018). Digital Image Processing. United Kingdom: Pearson.
10. Jain, A. K. (1989). Fundamentals of Digital Image Processing. India: Prentice Hall.

CO-PO mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	2	2	2	-	2	3	1	1
CO2	2	3	-	-	2	-	-	-	2	2	-	2	2	1	1
CO3	2	3	-	-	2	-	-	-	2	2	-	2	2	1	1
CO4	2	3	-	-	-	-	-	-	2	2	-	2	1	1	1
CO5	2	2	-	-	-	-	-	-	2	2	-	2	1	1	1

24AIM302 – Biomedical data acquisition & management **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To introduce students to the fundamental biomedical data acquisition and management
- To enable students to appreciate and apply the connection between pertinent technologies and real-world medical problems.
- To expose students to the wide range of applications using analytics and informed decision making.
- To equip students with advanced skills in trends like IoT, which are highly valued in healthcare practices.

Course Outcomes:

After completing this course, students should be able to

CO1: Apply knowledge to interpret data from sensors and instruments, using mathematical concepts.

CO2: Implement health information systems.

CO3: Develop skills in integrating biomedical data, creating warehouses, and using analytics for informed decision-making.

CO4: Evaluate trends like IoT and navigate big data challenges in healthcare practices.

Syllabus:

Unit 1: Introduction to Biomedical Data: Principles of biomedical sensors, instruments, and real-time signal processing. Advanced sensor technologies (wearables, implantables) for continuous monitoring.

Unit 2: Data Management in Biomedical Engineering: Health information systems, Electronic Health Records (EHR), and big data analytics. Security, privacy, and ethical considerations in managing patient information.

Unit 3: Biomedical Data Integration and Analytics: Techniques for integrating diverse biomedical data sources. Data warehouses, analytics, machine learning for predictive modeling. Patient-centric data integration, clinical trials, and research data management.

Unit 4: Emerging Trends and Applications: IoT for real-time biomedical data monitoring. Big data challenges and opportunities in biomedical engineering. Medical imaging data management and integration. Blockchain for data security, telehealth, and ethical considerations in biomedical data.

Textbooks / References:

1. Edward H. Shortliffe, James J. Cimino, "Biomedical Informatics: Computer Applications in Health Care and Biomedicine," 4th Edition, Springer, 2014.
2. Robert E. Hoyt, Ann K. Yoshihashi, "Health Informatics: Practical Guide for Healthcare and Information Technology Professionals," 7th Edition, Lulu, 2021.
3. Arnon Cohen, Israel Gannot, "Biomedical Signal Processing and Signal Modeling," CRC Press, 2022.
4. Sergio Manzi, Riccardo Rizzo, "Big Data in Healthcare: Statistical Analysis of Features in Selected Datasets," SpringerBriefs in Pharmaceutical Science & Drug Development, Springer, 2020.

CO-PO mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	2	-	-	1	2	2	-	2	3	2	2
CO2	2	-	-	-	3	-	-	1	2	2	-	2	3	3	2
CO3	3	3	-	-	3	-	-	1	2	2	-	2	3	2	2
CO4	3	3	-	-	3	-	-	1	2	2	-	2	3	2	2

24AIM303 – Biological systems, simulation and modelling Credits: 3 Weekly: 2-0-2

Course Objectives:

- This course is designed to introduce students to key ideas and mathematical tools of Systems Biology. Concepts of Systems.
- Students should be able to associate modelling with their origin in Dynamical Systems Theory and associated mathematical developments.
- Students should be able to use both traditional and high-throughput experimental techniques to explore those concepts and test hypotheses.
- The course will introduce students to a) deterministic models, b) stochastic models for cellular and molecular processes and c) graph theory-based analysis of biological networks.

Course Outcomes:

After completing this course, students should be able to

CO1: Apply Systems Biology concepts to analyze and model complex biological systems.

CO2: Utilize mathematical principles, including ODEs and stochastic modeling, to proficiently simulate and analyze diverse biological processes.

CO3: Employ computational tools, bioinformatics applications, and programming languages for comprehensive data analysis and large-scale simulations in systems biology.

CO4: Apply acquired knowledge in real-world scenarios, focusing on drug discovery, personalized medicine, and healthcare computational modeling.

Syllabus:

Unit 1: Foundations of Systems Biology: Introduction to systems biology and network theory. Principles of mathematical modeling in biology.Study of biological systems at different levels. Integration of omics data for holistic understanding

Unit 2: Mathematical Modeling in Biology: Mathematical principles for biological modeling. ODEs, PDEs, and stochastic modeling in biology. Agent-based modeling for individual-level interactions.

.

Unit 3: Computational Tools in Systems Biology: Computational systems biology modeling. Bioinformatics applications for data analysis. Simulation platforms and programming languages. High-performance computing for large-scale simulations.

.

Unit 4: Applications in Biomedical Engineering: Systems biology in drug discovery and personalized medicine. Computational models in healthcare. Case studies of systems biology in disease understanding. Ethical considerations in applying systems biology to biomedical engineering.

Textbooks / References:

1. Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, Ralf Herwig, "Systems Biology: A Textbook," Latest Edition, Wiley-VCH, 2017.
2. A.C. Fowler, J. Ockendon, J.R. King, "Mathematical Models in the Applied Sciences," Revised Edition, Cambridge University Press, 2017.
3. Andres Kriete, Roland Eils, "Computational Systems Biology," Latest Edition, Academic Press, 2019.
4. David W.Mount, "Bioinformatics: Sequence and Genome Analysis," Latest Edition, Cold Spring Harbor Laboratory Press, 2018.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	1	-	-	-	2	2	-	2	3	1	2
CO2	2	3	2	2	1	-	-	-	2	2	-	2	3	1	2
CO3	2	3	2	2	1	-	-	-	2	2	-	2	3	1	2
CO4	2	3	2	2	1	-	-	-	2	2	-	2	3	1	2

24AIM304 **Reinforcement learning** **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To provide a solid introduction to the field of reinforcement learning.
- To enable the students to learn about the core challenges and approaches, including exploration and exploitation.
- To expose the students to techniques like Monte Carlo and tabular methods.

Outcomes Course:

After completing this course, students should be able to
CO1: Demonstrate sound understanding of the foundations of Reinforcement Learning
CO2: Demonstrate proficiency in Multi-armed Bandits and Markov Decision Processes
CO3: Apply Monte Carlo Methods and Temporal-Difference Learning
CO4: Apply Tabular Methods in Planning and Learning
CO5: Employ Reinforcement Learning Concepts in Real-world Applications

Syllabus:

Unit 1: Introduction to Reinforcement Learning – History of Reinforcement Learning - Elements of Reinforcement Learning – Limitations and scope.

Unit 2: Multi-armed Bandits – Finite Markov Decision Processes – Dynamic Programming – Policy evaluation – Policy improvement – Policy Iteration – Value Iteration.

Unit 3: Monte Carlo Methods – Monte Carlo prediction – Monte Carlo control – Incremental Implementation – Temporal- Difference Learning – TD prediction – Q-Learning - n-step Bootstrapping.

Unit 4: Planning and Learning with Tabular Methods – Models and planning – Prioritized sweeping – Trajectory sampling – Heuristic search – Rollout algorithms.

Textbooks / References:

1. Richard S. Sutton and Andrew G.Barto, Reinforcement Learning, MIT Press, Second Edition, 2018.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	-	-	-	-	2	2	2	-	2	2	2	2
CO2	3	3	1	-	2	-	-	-	2	2	-	2	2	2	2
CO3	3	3	1	-	2	-	-	-	2	2	-	2	2	2	2
CO4	3	3	1	-	2	-	-	-	2	2	-	2	2	2	2
CO5	3	-	1	-	2	-	-	-	2	2	-	2	2	2	2

24AIM305 - Introduction to DBMS **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- This course aims to provide an understanding of the concepts of database design, database languages, database-system implementation and maintenance
- The course would afford know-how on the design and development of databases using SQL
- To introduce various database systems including modern databases systems apt for AI and ML applications.

Course Outcomes:

After completing this course, students should be able to

CO1: Demonstrate an understanding of relational data models, schema structures, and formal query languages for effective database design and implementation.

CO2: Apply normalization forms and decomposition techniques.

CO3: Implement transaction concepts and concurrency control mechanisms, including lock-based protocols and deadlock handling.

CO4: Apply knowledge of modern database systems, using SQL and Python to design databases suitable for modern applications.

Syllabus:

Unit 1: Introduction : History of database systems - Purpose of Database systems – File Systems Vs Database systems –Database architecture – Different Data models of Database. Relational Data Model: Structure of relational databases– Database schema – Formal Relational Query Languages. Database Design: Overview of the design process - The E-R Models – Constraints - Removing Redundant Attributes in Entity Sets - E-R Diagrams - Reduction to Relational Schemas.

Unit 2: Relational Database Design: Different Normal forms: 1NF, 2NF, 3NF, BCNF and Higher Normal Forms, Decomposition using Functional Dependencies - Functional Dependency Theory - Multi-valued dependency - SQL: Introduction to SQL – Intermediate SQL.

Unit 3: Transactions: Transaction concept – A simple transaction model - Transaction atomicity and durability – Serializability – Recoverable schedules, Casecadeless schedules. Concurrency control: Lock-based protocols – Locks, granting of locks, The two-phase locking protocol, Graph-based protocols. Deadlock handling: Deadlock prevention, Deadlock detection and recovery.

Textbooks / References:

1. Silberschatz A, Korth H F, SudharshanS. Database System Concepts, Sixth Edition, TMH publishing company limited;2011.
2. Garcia-Molina H, Ullman JD, Widom J. Database System; The complete book. Second Edition, Pearson Education India, 2011.
3. Elmasri R, Navathe SB. Fundamentals of Database Systems. Fifth Edition, Addison Wesley.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	2	2	-	2	1	2	1
CO2	3	2	-	-	-	-	-	-	2	2	-	2	1	2	1
CO3	3	2	-	-	-	-	-	-	2	2	-	2	1	2	1
CO4	3	2	-	-	-	-	-	-	2	2	-	2	1	2	1

23HUM233 – Free Elective (Glimpses of Indian economy and polity) Credits: 2 Weekly: 2-0-0

Course Objectives:

- Provide students with an overview of the historical evolution of the Indian economy and polity.
- Explore socio-economic and political structures from ancient civilizations to modern times.
- Examine major historical events and influential figures shaping India's economic and political landscape.

Course Outcomes:

After completing this course, students should be able to

CO1: Demonstrate a comprehensive understanding of India's economic and political history, covering key events and socio-economic structures.

CO2: Analyze socio-political structures in ancient India, evaluating elements in epics like Ramayana and Mahabharata.

CO3: Apply knowledge to understand classical India, including the rise of Magadha, impact of Buddhism and Jainism, and socio-economic dynamics.

CO4: Showcase understanding of medieval India, covering the advent of Islam, changes in social institutions, agrarian economy, and regional economies.

Syllabus:

Unit 1: Introduction: General Introduction; Primitive man and his modes of exchange – barter system; Prehistoric and proto-historic polity and social organization. Ancient India – up to 600 B.C. Early India – the vedic society – the varnashramadharma – socio-political structure of the various institutions based on the four purusarthas; The structure of ancient Indian polity – Rajamandala and Cakravartins – Prajamandala; Socio-economic elements from the two great Epics – Ramayana and Mahabharata – the concept of the ideal King (Sri Rama) and the ideal state (Ramarajya) – Yudhisthira's ramarajya; Sarasvati – Sindhu civilization and India's trade links with other ancient civilizations; Towards chiefdoms and kingdoms – transformation of the polity: kingship – from gopati to bhupati; The mahajanapadas and the emergence of the srenis – states and cities of the Indo-Gangetic plain

Unit 2: Classical India: 600B.C. – 1200 A.D. The rise of Magadha, emergence of new religions – Buddhism and Jainism – and the resultant socio-economic impact; The emergence of the empire – the Mauryan Economy and Kautilya's Arthasastra; of Politics and trade – the rise of the Mercantile Community; Elements from the age of the Kushanas and the Great Guptas; India's maritime trade; Dharma at the bedrock of Indian polity – the concept of Digvijaya: dharma-vijaya, lobha-vijaya and asura-vijaya; Glimpses into the south Indian economies: political economies of the peninsula – Chalukyas, Rashtrakutas and Cholas
Medieval India: 1200 A.D. – 1720 A.D. Advent of Islam – changes in the social institutions; Medieval India – agrarian economy, non-agricultural production and urban economy, currency system; Vijayanagara samrajya and maritime trade – the story of Indian supremacy in the Indian Ocean region; Aspects of Mughal administration and economy; The Maratha and other provincial economies

Unit 3: Modern India: 1720 – 1947 the Indian market and economy before the arrival of the European traders; Colonisation and British supremacy (dismantling of everything that was 'traditional' or 'Indian') – British attitude towards Indian trade, commerce and economy and the resultant ruining of Indian economy and business – man-made famines – the signs of renaissance: banking and other business undertakings by the natives (the members of the early Tagore family, the merchants of Surat and Porbander, businessmen of Bombay, etc. may be referred to here) – the evolution of the modern banking system; Glimpses into British administration of India and administrative models; The National movement and nationalist undertakings in business and industry: the Tatas and the Birlas; Modern India: the growth of large- scale industry – irrigation and railways – money and credit – foreign trade; Towards partition – birth of two new nations – division of property; The writing of the Indian Constitution – India becomes a democratic republic – a new polity is in place.
Independent India – from 1947: India since Independence – the saga of socio-political movements; Indian economy since Independence – the fiscal system – the five year plans – liberalisation – the GATT and after;

Globalisation and Indian economy; Impact of science and (new/ emerging) technology on Indian economy; Histories of select Indian business houses and business entrepreneurship.

Text Books/References:

1. Altekar, A. S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.
2. Sircar, D. C. Studies in the Political and Administrative Systems in Ancient and Medieval Times. New Delhi: Motilal Banarsidass.
3. Dutt, R. C. The Economic History of India. London, 1902.
4. Dharampal. Collected Works (Volumes IV & V). 7. Dharampal. Archival Compilations (unpublished).
5. Bajaj, Jitendra & M. D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.
6. Bajaj, Jitendra & M. D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.
7. Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.
8. Tripathi, Dwijendra. The Oxford History of Indian Business. New Delhi: Oxford University Press, 2004.
9. McGuire, John, et al, eds. Evolution of World Economy, Precious Metals and India. New Delhi: Oxford University Press, 2001.
10. Tripathi, Dwijendra and Jyoti Jumani. The Concise Oxford History of Indian Business. New Delhi: Oxford University Press, 2007.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-

Course Objectives

- Help students understand corporate culture, develop leadership qualities and become good team players
- Assist them in improving group discussion skills
- Help students to sharpen their problem solving and reasoning skills
- Empower students to communicate effectively

Course Outcomes

After completing this course, students will be able to

CO1 Soft Skills: To improve the inter-personal communication and leadership skills, vital for arriving at win-win situations in Group Discussions and other team activities.
CO2 Soft Skills: To develop the ability to create better impact in a Group Discussions through examination, participation, perspective-sharing, ideation, listening, brainstorming and consensus.
CO3 Aptitude: To identify, investigate and arrive at appropriate strategies to solve questions on geometry, statistics, probability and combinatorics.
CO4 Aptitude: To analyze, understand and apply suitable methods to solve questions on logical reasoning.
CO5 Verbal: To be able to use diction that is more refined and appropriate and to be competent in spotting grammatical errors and correcting them.
CO6 Verbal: To be able to logically connect words, phrases, sentences and thereby communicate their perspectives/ideas convincingly.

Soft Skills

Professional Grooming and Practices: Basics of corporate culture, key pillars of business etiquette – online and offline: socially acceptable ways of behavior, body language, personal hygiene, professional attire and Cultural adaptability and managing diversity. Handling pressure, multi-tasking. Being enterprising. Adapting to corporate life: Emotional Management (EQ), Adversity Management, Health consciousness. People skills, Critical Thinking and Problem solving.

Group Discussions: Advantages of group discussions, Types of group discussion and Roles played in a group discussion. Personality traits evaluated in a group discussion. Initiation techniques and maintaining the flow of the discussion, how to perform well in a group discussion. Summarization/conclusion.

Aptitude

Problem Solving III

Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.

Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.

Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.

Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.

Logical Reasoning: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding & Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Verbal

Vocabulary: Create an awareness of using refined language through idioms and phrasal verbs.

Grammar (Upper Intermediate-Advanced): Train Students to comprehend the nuances of Grammar and empower them to spot errors in sentences and correct them.

Reasoning: Enable students to connect words, phrases and sentences logically.

Oral Communication Skills: Aid students in using the gift of the gab to interpret images, do a video synthesis, try a song interpretation or elaborate on a literary quote.

Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style.

References:

Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.

Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.

*Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K*

Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.

The hard truth about Soft Skills, by Amazon Publication.

Verbal Skills Activity Book, CIR, AVVP

English Grammar & Composition, Wren & Martin

Public Sector – Engineer Management Trainee Recruitment Exam (General English)

Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce

Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations,

Amrita Vishwa Vidyapeetham.

Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.

How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.

How to Prepare for Data Interpretation for the CAT, Arun Sharma.

How to Prepare for Logical Reasoning for the CAT, Arun Sharma.

Quantitative Aptitude for Competitive Examinations, R S Aggarwal.

A Modern Approach to Logical Reasoning, R S Aggarwal.

A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

CO-PO Mapping

PO/ PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO															
CO									3	3	2	3			

1															
CO 2										3	2	2			
CO 3		3		2											
CO 4		3		2											
CO 5										3		3			
CO 6									3	3		3			

Micro-credential courses: Set 5 **Credits : 4** **Weekly: 3-0-2**

Items listed below (A to D) may change owing to temporal mandates and developments.

A. 24AIM331 Low field MRI imaging system construction 3 0 2 4

CO: The student should be able to construct a low-field MRI system.

Low-field MRI Scanner Based on Permanent Magnets
Low-field MRI: Parts- Magnet, RF amplifier, RF coil, Low pass filter, USRP (SDR)
Cheap-portable-MRI scanners

References:

1. Description of a Low-field MRI Scanner Based on Permanent Magnets https://ceur-ws.org/Vol-2688/paper15.pdf
2. https://www.opensourceimaging.org/
3.https://www.eurobioimaging.eu/upload/Agenda_VirtualPubOpenHardware_20230922_bis.pdf
4. Lukas Winter. Open-source magnetic resonance imaging: Improving access,science, and education through global collaboration
5. https://analyticalsciencejournals.onlinelibrary.wiley.com/doi/pdf/10.1002/nbm.5052
   A Framework for Advancing Sustainable MRI Access in Africa
6. https://www.medrxiv.org/content/10.1101/2022.05.02.22274588v1.full
7.https://www.science.org/content/article/mri-all-cheap-portable-scanners-aim-revolutionize-medical-imaging
8. On-site construction of a point-of-care low-field MRI system in Africa
   RF Power Amplifier https://github.com/LUMC-LowFieldMRI/RFPA_1kW
   miEye: bench-top cost-effective open-source single-molecule localization microscopy hardware and software platform
9. The Benchtop mesoSPIM: a compact and versatile open-source light-sheet microscope for imaging cleared tissue: https://www.biorxiv.org/content/10.1101/2023.06.16.545256v1.full

B. 24AIM332 Introduction to Cloud Computing 3 0 2 4

CO: The student should be able to develop and deploy cloud-based computing.

Basics of Cloud Computing – Characteristics and Use Cases; Introduction to Fog and Edge Computing; Web Application Development using Public Cloud Services; Virtualization – Hypervisor Virtualization and Container Virtualization; Introduction to Container Orchestration using Kubernetes.

References:

1. Rajkumar Buyya et. al., "Mastering Cloud Computing", McGraw Hill Education, 2013.
2. Kocher PS, "Microservices and Containers", Addison-Wesley Professional, 2018.
3. Menga J, "Docker on Amazon Web Services: Build, Deploy, and Manage Your Container Applications at Scale", Packt Publishing Ltd., 2018.

C. 24AIM333 Introduction to Full stack software development 3 0 2 4

CO: The student should be able to build dynamic web applications from start to finish.

Full Stack Development (Node.js based)
Contrast with classical web development
Full Stack Architecture
Installation and setup (Node, packages, VS Code)
Frontend (Languages, Frameworks, UI/UX design)
Backend (Languages, Useful packages)
Database (Connecting to DB, choosing the right DB)
Advanced use cases: Accessing third party APIs, Session Management, User Authentication flows

References:

1. Philip Ackermann, Full Stack Web Development The Comprehensive Guide, 2023
2. https://www.theodinproject.com/

D. 24AIM334 Making Ultra sound stethoscope: Principle, construction and analysis of data 3 0 2 4

CO: The student should be able to design and implement ultrasound stethescope for clinical applications.

Physics, Phenomena, Imaging technologies, System implementation, Signal processing, Biomedical relevance

References:

1. Jan Dodgeon , Clark's Essential guide to Clinical Ultrasound, CRC Press
2. N. Madhavanunni, A Portable Ultrasound Imaging Pipeline Implementation with GPU Acceleration on Nvidia CLARA AGX
3. https://github.com/echopen
4.https://www.msn.com/en-in/money/technology/how-ai-can-detect-diabetes-with-a-10-second-voice-sample/ar-AA1k160E
5. https://echonet.github.io/dynamic/ (A Large New Cardiac Motion Video Data Resource for Medical Machine Learning)
6.https://blogs.cardiff.ac.uk/bmccu/wp-content/uploads/sites/345/2016/06/TEE-physics-article.pdf
7. https://www.glowm.com/pdf/Ultrasound_in_obstetrics_and_gynecology-chapter1.pdf
8. http://home.ee.ntu.edu.tw/classnotes/us1/Chap1.pdf

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
A	3	3	3	3	1	-	-	-	2	2	-	2	2	1	2
B	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
C	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
D	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2

Semester VI

24AIM311 - Biostatistics **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To impart training on basic biostatistics and use of various statistical tools for biomedical data analysis.
- To apply statistical tools in experimental design and clinical trials

Course Outcomes:

After completing this course, students should be able to

CO1: Effectively analyze and summarize both categorical and continuous data using descriptive statistics.

CO2: Apply inferential statistics, including hypothesis testing and parametric tests, for meaningful interpretations and decisions.

CO3: Demonstrate proficiency in non-parametric tests and correlation techniques for data analysis.

CO4: Utilize statistical analysis and understand its applications in experimental design and clinical trials.

Syllabus:

Unit 1: Need of biostatistics Descriptive statistics: Population and samples descriptive methods for categorical data descriptive methods for continuous data probability and probability distributions types of data frequency distribution measures of central tendency measures of variability kurtosis and skewness Z score

Unit 2: Inferential statistics Parameters estimating and comparing the mean of population. Hypothesis testing: basic concepts and steps testing normal distribution - Kolmogorov-Simon test testing homogeneity of variance - Levine's test Z-tests dependent t-test, independent t-test, t-test as GLM, F-test, Chi-square test Type I and type II errors ANOVA, ANCOVA, factorial ANOVA, repeated-measures designs, mixed design ANOVA, post hoc procedures.

Unit 3: Non-parametric tests non-parametric and distribution-free tests - Mann-Whitney test Wilcoxon signed-rank test, Wilcoxon signed rank sum test, Kruskal-Wallis test, Friedman's ANOVA.

Unit 4: Correlation techniques Bivariate correlation - Pearson's correlation coefficient, Spearman's correlation coefficient Partial correlation regression - method of least squares, assessing goodness of fit multiple regression. Experimental design and clinical trials.

References:

1. Eberly, L. E., Le, C. T., Introductory Biostatistics. Germany: Wiley, 2016.
2. Glaser, A. N. High-yield Biostatistics. United States: Lippincott Williams & Wilkins, 2001.
3. Advances in Clinical Trial Biostatistics, United States: Taylor & Francis. 2003.

CO-PO Mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	1	-	-	-	-	-	-	-	2	2	-	2	3	2	2
CO2	-	2	-	3	-	-	-	-	2	2	-	2	3	2	2
CO3	-	3	1	--	3	-	-	-	2	2	-	2	3	2	2
CO4	-	-	-	-	1	1	2	2	2	2	-	2	3	2	2

23LSE311 Life Skills for Engineers IV Credits: 2 Weekly: 1-0-2

Course Objectives

· Help students prepare resumes and face interviews with confidence
· Support them in developing their problem-solving ability
· Assist them in improving their problem solving and reasoning skills
· Enable them to communicate confidently before an audience

Course Outcomes

CO1 - Soft Skills: To acquire the ability to present themselves confidently and showcase their knowledge, skills, abilities, interests, practical exposure, strengths and achievements to potential recruiters through a resume, video resume, and personal interview.
CO2 - Soft Skills: To have better ability to prepare for facing interviews, analyse interview questions, articulate correct responses and respond appropriately to convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.
CO3 - Aptitude: To manage time while applying suitable methods to solve questions on arithmetic, algebra and statistics.
CO4 - Aptitude: To investigate, understand and use appropriate techniques to solve questions on logical reasoning and data analysis.
CO5 - Verbal: To use diction that is less verbose and more precise and to use prior knowledge of grammar to correct/improve sentences.
CO6 -Verbal: To understand arguments, analyze arguments and use inductive/deductive reasoning to arrive at conclusions. To be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.

Syllabus

Soft Skills
Team Work: Value of teamwork in organizations, Definition of a team. Why team? Effective team building. Parameters for a good team, roles, empowerment and need for transparent communication, Factors affecting team effectiveness, Personal characteristics of members and its influence on team. Project Management Skills, Collaboration skills.
Leadership: Initiating and managing change, Internal problem solving, Evaluation and co-ordination, Growth and productivity, Importance of Professional Networking.
Facing an interview: Importance of verbal & aptitude competencies, strong foundation in core competencies, industry orientation / knowledge about the organization, resume writing (including cover letter, digital profile and video resume), being professional. Importance of good communication skills, etiquette to be maintained during an interview, appropriate grooming and mannerism.
Aptitude
Problem Solving II
Sequence and Series: Basics, AP, GP, HP, and Special Series.
Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.
Logical reasoning: Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.
Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.
Competitive examination papers: Discussion of previous year question papers of CAT, GRE, GMAT, and other management entrance examinations.
Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.
Verbal
Vocabulary: Empower students to communicate effectively through one-word substitution.
Grammar: Enable students to improve sentences through a clear understanding of the rules of grammar.
Reasoning: Facilitate the student to tap his reasoning skills through Syllogisms, critical reasoning arguments and logical ordering of sentences.
Reading Comprehension (Advanced): Enlighten students on the different strategies involved in tackling reading comprehension questions.
Public Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently before an audience.

Writing Skills: Practice formal written communication through writing emails especially composing job application emails.

References:

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Public Sector – Engineer Management Trainee Recruitment Exam (General English)
9. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
10. A Modern Approach to Verbal Reasoning – R.S. Aggarwal
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
15. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
16. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
17. A Modern Approach to Logical Reasoning, R S Aggarwal.
18. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwa

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									3	3		2
CO2								2	3	3		2
CO3		3		2								
CO4		3		2								
CO5										3		3
CO6									3	3		3

24AIM431 - Bio Medical Instrumentation **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- Solve Engineering Problems related to medical field
- Understand medical diagnosis and therapy
- Provide latest knowledge of medical assistance / techniques and therapeutic
- Bring out the important and modern methods of imaging techniques

Course Outcomes:

After completing this course, students should be able to

CO1: Discuss the Physiology and Anatomy of various Physiological systems in the Human Body and Elaborate the origin and propagation of Bio-potentials in Human body

CO2: Choose the Electrodes for Physiological Signals Acquisition and Select suitable Sensors for Measuring Nonelectrical parameters measurement

CO3: Choose suitable Sensors for measuring Physiological parameters and appraise the importance of Therapeutic and Physiological Assist Devices in the Intensive Care Units

CO4: Distinguish various Imaging Techniques to Diagnose abnormality and Discuss the Safety precautions and Standards while using Diagnostic and Therapeutic equipment

Syllabus:

Unit 1: Human Physiology & Electrical Activities in Myocardial Cell-Circulatory System – Cardio Vascular System – Respiratory System – Central Nervous System., Basic Cell Structure, Transport of Ions through the cell membrane, Neuron – Axon – Synapse – Propagation of electrical impulses along the axon – Characteristics of Resting potential, Action potential.

Unit 2: Electro–Physiological & Non-Electrical Measurements-Basic components of a biomedical system – Electrode theory – Half cell potentials, electrodes tissue interface–Bipolar and unipolar electrodes – Types of electrodes–Micro, needle and surface electrodes– Isolation amplifier. Characteristics & Recording of Various Diagnostic Signals: ECG – EEG – EMG – ERG. Measurement of blood pressure – Cardiac output – Cardiac rate – Heart sound – Respiratory rate –pH of blood, ESR, GSR.

Unit 3: Transducers for Biomedical Applications-Capacitive Transducers: Heart sound measurement, Pulse pick up–Photoelectric Transducers: Pulse transducers, Blood pressure, oxygen Analyses – Piezoelectric Transducers – Pulse pickup– Ultrasonic blood flow meter. Assisting & Therapeutic Equipment-Cardiac Pacemakers –Cardiac Defibrillators – Ventilators – Diathermy – Heart – Lung machine – Audio meters – Dializers.

Unit 4: Modern Medical Imaging Systems **-**X-ray Machines – Radio graphic – Computed Tomography– Magnetic Resonance imaging system – Ultrasonic imaging system – Medical thermography– Single-photon emission computed tomography (SPECT)– Positron emission tomography (PET). Calibration of medical equipment and patients' safety. Standards – Horizontal, semi-horizontal and Vertical standards.

Textbooks / References:

1. Paul H. King, Richard C. Fries, Arthur T. Johnson,*Design of Biomedical Devices and Systems*, 4th Edition, CRC Press, 2018
2. Leslie Cromwell, Fred.J.Weibell and Erich A. Pfeiffer, *Biomedical Instrumentation and Measurements*, 2nd Edition, PHI, 2016.
3. R.S. Khandpur, *Handbook of Bio-Medical Instrumentation*, 3rd Edition, McGraw Hill Education, 2014
4. John Webster, *Medical Instrumentation Application & Design,* 4th Edition, Wiley, New York, 2010.
5. Yang,J. and Posh,N. (Edts),*Recent Applications in Biometrics,* InTech (Open Access Book – online), Chapter 12, 2011
6. Joel Mispelter, MihaelaLupu and Andre Briguet, *NMR Probe Heads, for Biophysical and Bio Medical Experiments- Theoretical Principles & Practical Guidelines,* Imperial College Press, 2006.
7. M. Arumugam, *Biomedical Instrumentation*, 2nd Edition, Anuradha Agencies, 2002.
8. Richard C. Fries, *Handbook of Medical Device Design,* Marcel Dekker Inc. Publications, 2001.
9. NPTEL- https://nptel.ac.in/courses/108105101/

List of Experiments:

1. Recording and analysis of ECG and verification of Kirchhoff's law in Einthoven triangle
2. Recording and analysis of EEG
3. Recording and analysis of EMG
4. Measurement of arterial Blood Pressure using Sphygmomanometer
5. Measurement of Pulse rate & Oxygen saturation in blood (SpO_2) using Pulse Oximeter
6. Measurement of Respiration rate using Spirometer
7. Perform audibility test using Audiometer
8. Study of Pacemaker system using Modular setup
9. Biomedical Signal Processing using MATLAB-Removal of various noises from the ECG and medical image

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	-	-	-	2	-	-	2	2	-	2	3	3	3
CO2	-	1	-	-	-	-	-	-	2	2	-	2	3	3	3
CO3	-	1	1	-	-	-	-	-	2	2	-	2	3	3	3
CO4	-	-	-	3	-	-	3	-	2	2	-	2	3	3	3

24AIM432 - Cell Culture and Tissue Engineering **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To make students understand the Basic Utility and Potential of Tissue Engineering Principles.
- To Create Problem Solving Ability Among Students for Developing Strategies to Build Tissue Engineering Solutions.
- To Encourage Students for Fabricating Tissue Engineering Products.

Course Outcomes:

After completing this course, students should be able to

CO1: Understand the fundamentals of stem cell tissue engineering, growth factors, and the role of extracellular matrix in tissue engineering applications.

CO2: Explore enabling technologies such as polymer scaffolds, biomimetic materials, nanocomposites, and bioreactors used in tissue engineering.

CO3: Apply tissue engineering concepts to various applications including human skin, nerve, musculoskeletal, bone, cartilage, temporomandibular, and smooth muscle tissue engineering.

CO4: Examine advanced tissue engineering applications like vascular grafts, cardiac, heart valve, urologic organ, hepatic, renal, dental, and tracheal tissue engineering, considering regulatory issues.

Syllabus:

Unit 1: Fundamental Of Tissue Engineering Fundamentals Of Stem Cell Tissue Engineering; Growth Factors; Extracellular Matrix: Structure, Function And Tissue Engineering Application; Mechanical Forces On Cells; Cell Adhesion; Cell Migration.

Unit 2: Tissue Engineering Enabling Technologies Polymer Scaffold For Tissue Engineering Applications; Biomimetic Materials; Nanocomposite Scaffolds Tissue Engineering; Bioreactors; Regulatory Issues In Tissue Engineering.

Unit 3: Tissue Engineering Application I Bioengineering Of Human Skin Substitute; Nerve Tissue Engineering; Musculoskeletal Tissue Engineering; Bone Tissue Engineering; Cartilage Tissue Engineering; Temporomandibular Tissue Engineering; Smooth Muscle Tissue Engineering; Esophagus Tissue Engineering.

Unit 4: Tissue Engineering Application II Vascular Graft Tissue Engineering Cardiac Tissue Engineering; Heart Valve Tissue Engineering; Urologic Organ Tissue Engineering; Hepatic Tissue Engineering; Renal Tissue Engineering; Dental Tissue Engineering; Tracheal Tissue Engineering.

References:

1. Clemens van Blitterswijk, Tissue Engineering, Academic Press, 2008.
2. Lanza, R., Langer, R., Vacanti, J. P., & Atala, A. (Eds.), Principles of tissue engineering. Academic press, 2020.
3. Palsson, B., Hubbell, J. A., Plonsey, R., & Bronzino, J. D., Principles, and applications in engineering series. Tissue Engineering, CRC Press, Boca Raton, FL, 2003

CO-PO Mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	1	2	-	-	-	1	-	-	2	2	-	2	3	3	3
CO2	-	1	2	1	3	-	-	-	2	2	-	2	3	3	3
CO3	-	-	1	1	-	1	1	-	2	2	-	2	3	3	3
CO4	-	1	-	-	3		1	2	2	2	-	2	3	3	3

24AIM433 - Emerging Areas in medical Engineering **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To learn about the recent areas of Research in Biomedical Engineering.
- To learn about the modern approaches of surgery and prosthetic devices.

Course Outcomes:

After completing this course, students should be able to

CO1: Analyze and evaluate the transformative impact of emerging technologies on healthcare practices and biomedical engineering.

CO2: Demonstrate a comprehensive understanding of the neural foundations of cognition and behavior through the integration of cognitive neuroscience and computational modeling.

CO3: Demonstrate practical skills in applying machine learning techniques to healthcare scenarios, including medical imaging and diagnostic processes.

CO4: Assess, adopt, and contribute to the advancement of prosthetic and surgical technologies within the field of biomedical engineering.

Syllabus:

Unit 1: Emerging Technologies in Healthcare Regenerative Medicine, Robotics, DNA Data Storage, Industry 4.0, Blockchain, CRISPR, AR/ VR, 5G, Gaming

Unit 2: Cognitive Neuroscience, Neuropsychology, Experimental Psychology, Neurology, Computational Modelling, Cognitive Deficits Associated with Clinical Condition, Understanding of Neural Bases of Cognition and Behaviour.

Unit 3: Machine Learning Applications in Healthcare Introduction, Data preparation, Feature engineering: transformation, extraction and selection, Machine learning modes to classify healthcare data: logistic regression, neural network, support vector machine, Medical Imaging diagnosis, medical diagnosis, and identification.

Unit 4: Technological Developments in prosthetics & Surgical Devices Chip-enabled prosthetics, prosthetic & orthotics on demand, Robot-assisted surgery, image-guided Deformity Correction and Stabilization, software for 3D solid and mesh based nurbs modelling.

References

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2. https://health.google/health-research/
3. https://www.ibm.com/in-en/watson-health
4. Machine Learning with Health Care Perspective: Machine Learning and Healthcare, 2020. Germany: Springer International Publishing.
5. Rus, D., Nordlinger, B., Villani, C., Healthcare and Artificial Intelligence. Germany: Springer International Publishing, 2020.
6. Journal of Prosthetics and Orthotics International 9. Herzenberg, J., Paley, D. 2014.
7. Principles of Deformity Correction. Germany: Springer Berlin Heidelberg.
8. Mohammad, N., Handbook of Robotic and Image-Guided Surgery. Netherlands: Elsevier Science, 2019.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	1	-	3	-	3	-	2	2	-	2	3	3	3
CO2	1	1	2	3	3	-	-	3	2	2	-	2	3	3	3
CO3	-	3	3	1	3	3	-	-	2	2	-	2	3	3	3

CO4	-	-	-	-	3	-	3	2	2	2	-	2	3	3	3

24AIM434 - Biophotonics **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To differentiate the various working principles of optical imaging systems
- To outline the various applications of biosensors in medicine
- To analyse the working principle of flow cytometer
- To describe the importance of photodynamic therapy in treatment of diseases
- To explain about Bionanophotonics and other advance topics

Course Outcomes:

After completing this course, students should be able to

CO1: Integrate their understanding of biophotonics with fundamental principles of light and matter, demonstrating a profound comprehension of the interdisciplinary nature of this field.

CO2: Apply advanced laser technology and nonlinear optics in the context of biophotonics, including the quantitative description of light, radiometry, time-resolved studies, and laser safety protocols.

CO3: Demonstrate principles and techniques of bioimaging, encompassing various microscopy methods, optical coherence tomography, spectral and time-resolved imaging, and related technologies for applications in the biomedical domain.

CO4: Demonstrate expertise in the application of biosensors, flow cytometry, and photodynamic therapy, with a nuanced understanding of microarray technology for genomics and proteomics, basic principles of flow cytometry, and the fundamental aspects of photodynamic therapy.

CO5: Gain insights into emerging areas such as bionanophotonics, array technologies, optical diagnostics, targeted therapy, super-resolution microscopy techniques, ultrasound-mediated biophotonics imaging, and the application of deep learning in biophotonics through relevant case studies.

Syllabus:

Unit 1: Introduction Biophotonics – A new frontier; Fundamentals of Light and Matter – Nature of Light, Quantized States of Matter, Intermolecular Effects, Three Dimensional Structures and Stereoisomers; Basics of Biology; Fundamentals of Light-Matter Interactions

Unit 2: Bioimaging Principles of Lasers, Current Laser Technology and Nonlinear Optics – Quantitative Description of Light: Radiometry, Time-Resolved Studies, Laser Safety; Photobiology – Photo processes in Biopolymers, In Vivo Photo execution, In Vivo Spectroscopy, Optical Biopsy, Single-Molecule Detection; Principles and Techniques of Bioimaging – Transmission and other Microscopy, Optical Coherence Tomography, Spectral and Time Resolved Imaging and other related Imaging; Applications

Unit 3: Biosensors, Flow Cytometry and Photodynamic Therapy Introduction to Biosensors, Principles of Biosensing, Different Biosensors; Microarray Technology for Genomics and Proteomics – DNA, Protein, Cell, Tissue Microarray Technology; Basics of Flow Cytometry, Commercial Flow Cytometry; Basic Principles of Photodynamic Therapy, Photosensitisers, Current Research and Future Directions

Unit 4: Emerging Areas and Case Study. Bionanophotonics and Array Technologies, Optical Diagnostics and Targeted Therapy, Laser Scissors, Super Resolution Microscopy Techniques (STED, STORM, PALM), Ultrasound-mediated Biophotonics Imaging, A Case Study on Deep Learning for Biophotonics, A Case Study on Biophotonics to Occupy Crucial Role in Clinical Assessment of Cancers.

References:

1. Prasad P. N, Introduction to Biophotonics. Germany: Wiley, 2014.
2. Biophotonics for Medical Applications, Netherlands: Elsevier Science, 2015.
3. Prasad P. N, Nanophotonics. Germany: Wiley, 2004.
4. G. Keiser, Biophotonics: Concepts to Applications. Singapore: Springer Singapore, 2018.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	2	2	-	2	1	2	-
CO2	-	1	2	1	-	2	-	-	2	2	-	2	2	2	1
CO3	-	1	3	3	-	-	-	-	2	2	-	2	2	2	-
CO4	-	1	2	-	-	-	1	1	2	2	-	2	2	1	-
CO5		-	-	-	-	-	2	3	2	2	-	2	2	-	-

24AIM435 - Lab-On-Chip Devices **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To Make Students Understand the Basic Concepts of Lab-On-Chip Architecture.
- To Create Problem Solving Ability Among Students for On-Chip Solution Development.
- To Encourage Students for Designing Lab-On-Chip Healthcare Products.
- To Prepare Students for Advance Level Courses Lab on Chip Fabrication Technology.

Course Outcomes:

After completing this course, students should be able to

CO1: Design and simulate Lab-On-A-Chip devices, considering fluidic platforms and components.

CO2: Demonstrate proficiency in the fabrication of Lab-On-Chip products, employing techniques such as soft lithography and utilizing DC and AC fields for microsystems.

CO3: Apply molecular biology techniques on a chip, including sample preparation, microfluidic immunoassays, and chips for genomics and proteomics.

CO4: Utilize cell-based chips for biotechnological applications, including microfluidic flow cytometers, cell sorting, cell trapping, and microfluidic cell culture.

CO5: Perform biochemical analysis using force sensors, demonstrating an understanding of the integration of various detection methods, including electrical, optical, and thermal approaches, in Lab-On-Chip devices.

Syllabus:

Unit 1: Introduction To Lab-On-Chip the Diffusion of Molecules and Microscale Mixing, Technological Production of Components: Mixers and Pumps, Separation, Purification, Concentration Technologies, Simulation and Design of Mixing Devices for Chemical Reactors, Design and Simulation of Lab-On-A-Chip Devices, A Considered Approach to Lab-On-A-Chip Fabrication, Fluidic Platforms and Components of Lab-On-A-Chip Devices.

Unit 2: Fabrication of Lab-On-Chip Products DC Fields In Microsystems: Electro-Osmosis and Electrophoresis, AC Fields In Microsystems: Spectroscopy and Dielectrophoresis, Soft Lithography, Novel Methods and Fabrication of Lab-On-A-Chip Devices, Detection Methods – Electrical, Optical, Thermal, Applications of Paper-Based Diagnostics, Microfluidics in Planar Microchannels: Synthesis of Chemical Compounds On-Chip.

Unit 3: Molecular Biology on A Chip Sample Preparation: Fluid Conditioning for Cell and Cell Free Analysis; Microfluidic Immunoassay: Pregnancy Test, Homogeneous Phase Immunoassays, Heterogeneous Phase; Chips for Genomics and Proteomics: Microarray and DNA Based Molecules, Automated DNA Purification, Microfluidic Cdna Synthesizer, PCR Chips, Protein Immunoblotting on Chip, Protein Crystallization Chip; Electrospray Mass Spectrometry; Biochemical Analysis Using Force Sensors.

Unit 4: Cell-Based Chip for Biotechnology Microfluidic Flow Cytometers; Cell Sorting: RBC Assays, Electrokinetic Routing of Cells, Dean Flow in Spiral Microchannels, Cell Sorting Using Surface Acoustic Waves; Cell Trapping: Neuro Cages, PEG Microwells, PDMS Microwells, Dielectrophoretic Trap, Micromagnetic Traps, Hydrodynamic Traps, Trapping Cells Using Antibodies, Microdroplets Culture and Assays; Microfluidic Cell Culture Laboratory; Micro Bioreactors; Patch Clamp Chips.

References:

1. Oppenheim Oosterbroek and van den Berg, Lab-on-a-chip: miniaturized systems for (bio)chemical analysis and synthesis. Elsevier, 2003.
2. Marc J. Madou, Fundamentals of Microfabrication, The Science of Miniaturization. CRC Press, 2002.
3. Tabeling, Introduction to Microfluidics. Oxford, 2005.
4. Nguyen and Wereley, Fundamentals and applications of microfluidics. Artech, 2006.
5. Gescheke et al, Microsystems Engineering of Lab-on-a-Chip Devices. Wiley, 2004.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	-	-	3	-	-	-	-	-	2	2	2	2
CO2	1	1	1	-	3	3	-	2	2	2	-	2	2	2	2
CO3	-	3		1	3	-	-	-	2	2	-	2	2	2	2
CO4	3	2	2	-	3	-	-	-	2	2	-	2	2	2	2
CO5	-	-	2	-	-	-	3	2	2	2	-	2	2	2	2

24AIM436 - AI in emergency, forensic and molecular medicine **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To make students appreciate basic ideas in emergency medicine and how AI could help physicians better serve the patients in acute clinical setups.
- To introduce students to the various challenges in forensic medicine and provide an overview of how AI could aid solving the emerging challenges in this field.
- To acquaint students with molecular medicine and how AI technologies are reinventing the landscape therein.

Course Outcomes:

After completing this course, students should be able to

CO1: Analyse the basic challenges in clinical emergencies and provide tangible computational and AI-based solutions.

CO2: Apply AI-based technologies to solve emerging divergent problems in forensic medicine.

CO3: Enable and demonstrate the application of AI in molecular medicine

Syllabus:

Unit 1: Introduction to emergency medicine and associated clinical issues; examples of applications of AI

Unit 2: Introduction to forensic medicine and toxicology; how AI helps solve issues

Unit 3: Introduction to molecular medicine and the roles AI plays in the emerging scenarios

References:

Chenais G, Lagarde E, Gil-Jardiné C. Artificial Intelligence in Emergency Medicine: Viewpoint of Current Applications and Foreseeable Opportunities and Challenges. J Med Internet Res. 2023 May 23;25:e40031. doi: 10.2196/40031.

Vearrier L, Derse AR, Basford JB, Larkin GL, Moskop JC. Artificial Intelligence in Emergency Medicine: Benefits, Risks, and Recommendations. J Emerg Med. 2022 Apr;62(4):492-499. doi: 10.1016/j.jemermed.2022.01.001.

Wankhade TD, Ingale SW, Mohite PM, Bankar NJ. Artificial Intelligence in Forensic Medicine and Toxicology: The Future of Forensic Medicine. Cureus. 2022 Aug 25;14(8):e28376. doi: 10.7759/cureus.28376.

Tournois, L., Trousset, V., Hatsch, D. *et al.* Artificial intelligence in the practice of forensic medicine: a scoping review. *Int J Legal Med* **138**, 1023–1037 (2024). https://doi.org/10.1007/s00414-023-03140-9

Gomes B, Ashley EA. Artificial Intelligence in Molecular Medicine. N Engl J Med. 2023 Jun 29;388(26):2456-2465. doi: 10.1056/NEJMra2204787.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	3	-	-	2	-	2	2	3	3	3
CO2	3	3	2	-	-	3	-	-	2	-	2	2	3	3	3
CO3	3	3	2	-	-	3	-	-	2	-	2	2	3	3	3

24AIM437 - Advanced Biomechanics **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To equip students with adequate knowledge on bio-mechanics and their relations to robotic systems
- To familiarize students with various components of biomechanics and robots
- To provide students the concept of designing biomechanical robotics systems

Course Outcomes:

After completing this course, students should be able to

CO1: Appreciate the human anatomy and various components of biomechanical and robotic systems

CO2: Design bio-mechanical system using software tools and analyse various bio-mechanical devices using finite element analysis.

Syllabus:

Unit 1: Bio-mechanics and Robotics - Definition, Human Anatomy: Human Body Modelling, Position and Direction representation of human body, Common Movements, Major Joints and muscle, Anthropometric Data. Introduction to Bio-inspired robots – Legged locomotion: bipeds – multi-legged robots – multi-limbed robots, limbless, aquatic locomotion – Types: humanoid robots, swarm robots, soft robots

Unit 2: Basic blocks of Biomechanical and robotic systems – comparison – Actuators: Biological Actuators - Muscle – Macro-dynamics – Types - Sliding Filament Theory, Artificial Actuators – Pneumatic Actuation – Artificial Muscles - Hydraulic Actuation - Electric Actuator – voice coils – linear, stepper, servo motors, Electro-active Polymers - Shape-Memory Alloys Sensors: Biological Sensors - Sensing in Robotics and Biomechanics, Control: Nervous System - Classical controllers and Artificial Intelligence

Unit 3: Mechanics- Types and Units - Principles of Biomechanics: Movement principles – Projectile principles. Qualitative Analysis - four-task model – Application of qualitative analysis: Arm movements - Batting, Free throwing, Catching, Leg movements – Squat, Drop jump, Gait generation for human movements in robotic systems

Unit 4: Biomechanical systems - types - prosthetics – human assistive robots – artificial organs. Design process & factors, Micro Engineering – Prototyping - Software based design – Tools: MIMICS, CAD/CAM. Finite Element Analysis– Introduction - Methodology for the finite element analysis of biomechanical systems - Finite-element-models of the implant-bone-compound - Finite-element-method for preclinical analysis of an Endo-prosthetic implant.

References

1. Popović, M.B., Biomechanics and robotics. Pan Stanford Publishing Pte. Ltd. ISBN 978-981-4411-37-0, 2013.
2. Knudson D., Fundamentals of biomechanics. Springer Science & Business Media.ISBN 978-0-387-49311-4, 2007.
3. Huston R., Principles of biomechanics. CRC press. 2008.
4. David Moratal, Finite Element Analysis, ISBN 978-953-307-123-7, 698 pages, Publisher: Sciyo, published August 17, 2010.
5. D N Ghista, Biomechanics of Medical Devices, Macel Dekker, 1982.

CO-PO Mapping

PO/PSO CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	-	-	--	-	-	2	2	-	2	2	2	2
CO2	3	3	1	-	3	-	-	-	2	2		2	2	2	2
CO3	3	3	1	-	3	-	-	-	2	2	-	2	1	1	1
CO4	3	2	2	-	3	-	-	-	2	2	-	2	1	1	-

24AIM438 - Artificial Organs **Credits: 3** **Weekly: 2-0-2**

Course objectives:

- To have an overview of artificial organs and transplants
- To describe the principles of implant design with a case study
- To study about various organs replacement concept
- To study about physical parameters for concept design of artificial organs

Course Outcomes:

After completing this course, students should be able to
CO1: Design artificial hearts and circulatory assist devices based on engineering principles.
CO2: Demonstrate knowledge of the various components of artificial blood and their clinical applications.
CO3: Understand the structure and functions of artificial skin, along with its clinical uses and types.
CO4: Evaluate the design and functionality of artificial pancreas systems and artificial lungs for gas exchange.

Syllabus:

Unit 1: Artificial Heart & Circulatory Assist Devices Engineering Design of artificial Heart & Circulatory Assist Devices; Detailed Design to execute the plant; Heart Assist Technology; Blood Pumps; Prosthetic Heart Valves.

Unit 2: Artificial Blood & Cochlear Implant Blood components & characteristics; Oxygen carrying plasma expanders; Blood substitutes; Crystalloid & colloidal solutions as volume expanders; Artificial oxygen carriers; Fluorocarbons; Haemoglobin based artificial blood. Cochlear Implant: Introduction; candidates for implant; the auditory system; the auditory periphery; theory of operation; evaluation of cochlear prosthesis; benefits & risks of implantation; the cost of implantation; the future of cochlear prosthesis.

Unit 3: Artificial Skin Structure & functions of skin; Characteristics & clinical use of skin substitutes; Two conceptual stages in the treatment of massive skin loss; Skin substitutes: characteristics & uses, types of skin substitutes.

Unit 4: Artificial Pancreas & Artificial Lungs Parenteral Structure & function of Pancreas; Endocrine pancreas & insulin secretion; Diabetes; Insulin therapy; Insulin administration systems; Insulin production systems. Artificial Lungs: Gas exchange systems; Cardiopulmonary Bypass; Oxygen & CO2 transport; Coupling of oxygen & CO2 exchange; Shear-Induced Transport Augmentation and Devices for Improved Gas Transport.

Textbooks/References:

1. Bronzino J. D, The Biomedical Engineering Handbook. Germany: CRC Press, 2000.
2. Artificial Organs, Netherlands: Springer London. Optional Materials: Reference Books, 2009.
3. Miller G. E., Artificial Organs. United States: Morgan & Claypool Publishers, 2006.
4. Schoen, F. J., Ratner, B. D., Hoffman, A. S., Lemons, J. E,. Biomaterials Science: An Introduction to Materials in Medicine. Netherlands: Elsevier Science, 2004.

CO-PO Mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	2	2	-	2	-	-	2	2	-	-	3	2	2
CO2	-	3	2	2	-	-	-	-	2	2	-	-	3	2	2
CO3	-	1	3	-	3	-	2	-	2	2	-	2	3	2	2
CO4	-	-	-	3	-	-	2	2	2	2	-	-	3	2	2

24AIM439 – Advanced Bioinformatics **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To understand gene sequences, sequence matching and other related methods
- To understand mathematical optimization concepts related to Bioinformatics
- To understand algorithms related to Bioinformatics

Course Outcomes:

After completing this course, students should be able to

CO1: Analyze and interpret molecular biology and genetic data, applying principles of phenotypes and genomics.

CO2: Demonstrate proficiency in utilizing databases for molecular biology, understanding DNA sequencing techniques, and addressing ethical considerations in bioinformatics.

CO3: Apply principles of protein structure and classification to visualize, analyze, and predict protein structures using relevant tools and databases.

CO4: Implement various algorithms in bioinformatics for sequence analysis, database searching, and DNA digital data storage.

CO5: Utilize machine learning techniques for bioinformatics applications, including probabilistic frameworks, neural networks, hidden Markov models, and stochastic grammar.

Syllabus:

Unit 1: Introduction Phenotype, Central and Peripheral Dogmas, Systems Biology, Human Genome, Databases in Molecular Biology, Genetics Background, Maps and Tour Guides, DNA Sequencing, Next-Generation Sequencing, Ethical, Legal and Social Issues, Genomes, Transcriptomes and Proteomes, Genomes of Prokaryotes and Eukaryotes, Sequence Alignment, Phylogeny

Unit 2: Structural Bioinformatics Principles of Protein Structure and Classification: Properties of Amino Acids and Peptide Bonds, Ramachandran Plot, Secondary Structures, Motifs and Folds, Protein Structure Visualization, Tools and Analysis of Protein Structures, Protein Structure Prediction and Modelling, Protein Databank, Concepts of B-factor and R-factor, Protein Structural Alignment and Superposition, Protein Fold Classification, CATH, SCOP and FSSP Databases

Unit 3: Algorithms in Bioinformatics Algorithms and Complexity, Exhaustive Search, Greedy Algorithms, Dynamic Programming Algorithms, Randomized Algorithms, Graph Algorithms, Dot Plots, Measures of Sequence Similarity, Applications of Multiple Sequence Alignment to Database Searching, DNA Digital Data Storage

Unit 4: Machine Learning Approach for Bioinformatics Machine-Learning Foundations: The Probabilistic Framework, Machine Learning Algorithms, Applications of Neural Networks in Bioinformatics, Hidden Markov Models, Stochastic Grammar, and Linguistics

Textbooks/References:

1. Lesk A., Introduction to Bioinformatics. United Kingdom: Oxford University Press, 2019.
2. Bach, F., Brunak, S., Baldi, P., Baldi, P. P., Bioinformatics. Cambridge: Bradford, 2001.
3. Mount, D. W, Bioinformatics: Sequence and Genome Analysis. Thailand: Cold Spring Harbor Laboratory Press, 2004.
4. Baxevanis, A. D., Ouellette, B. F. F. Bioinformatics: a practical guide to the analysis of genes and proteins, 3rd ed. India: Wiley India Pvt. Limited, 2009.

CO-PO Mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	1	3	1	-	3	-	-	-	2	2	-	2	3	3	3
CO2	1	1	1	-	3	-	-	-	2	2	-	2	3	3	3
CO3	1	1	1	-	3	-	-	-	2	2	-	2	3	3	3
CO4	1	2	2	-	3	-	-	-	2	2	-	2	3	3	3

Items listed below (A to D) may change owing to temporal mandates and developments.

A. 24AIM341 - SVD and ADMM revisited 3 0 2 4

CO: The student should be able to apply SVD and ADMM for LP, QP and LASSO.

SVD and Latent Semantic Analysis-SVD and Image Compression-DCT-SVD based Steganography - Pseudo Inverse, Multivariate regression, Classification-SVD and large Language model fine tuning-Constraint optimization and Lagrangian Multiplier- ADMM Philosophy, ADMM for LP, QP, LASSO

References:

1. https://www.cs.cmu.edu/~venkatg/teaching/CStheory-infoage/book-chapter-4.pdf
2. James Bisgard (author) Analysis and Linear Algebra: The Singular Value Decomposition and Applications
3. Gilbert Strang , https://math.mit.edu/~gs/linearalgebra/ila5/linearalgebra5_7-1.pdf
4. https://web.stanford.edu/class/cs276/handouts/lecture13-lsi-handout-1-per.pdf
5. DCT-SVD based Steganography https://eudl.eu/pdf/10.4108/eai.28-9-2020.166365
6. https://medium.com/@Shrishml/lora-low-rank-adaptation-from-the-first-principle-7e1adec71541
7. https://web.stanford.edu/~boyd/papers/admm/

B. 24AIM342 - Distributions Derived from Normal distributions and Statistical Inference 3 0 2 4

CO: The student should be able to work with different distributions and apply sampling methods and statistical tests.

Univariate Normal Distribution-Moment generating function and Convolution-Sum of n IID standard normal random variables-Sampling distribution of mean of random sample and estimation theory-pdf of square of standard normal random variable- Chi-square distribution-Sum of Squares of n IID standard normal random variables-Chi-square distribution with parameter n -F-distribution - Ratio of two Chi-square distributions-Testing of Hypothesis-Analysis of Variance.

References:

1. T. Hastie Computer Age Statistical Inference
2. https://stat206-winter21-01.courses.soe.ucsc.edu/system/files/attachments/efron-hastie-2016.pdf
3. https://online.stat.psu.edu/stat504/lesson/statistical-inference-and-estimation

C. 24AIM343 - Spatio-temporal Medical Data Analytics with VMD and DMD 3 0 2 4

CO: The student should be able to apply VMD and DMD for ECG and EEG signal analysis.

Introduction to Variational mode decomposition and applications in ECG and EEG analysis-Time-Varying Graph Mode Decomposition-Introduction to Dynamic mode decomposition and applications in Epileptic EEG analysis-Dynamic mode decomposition with dependent structure among observables (Graph DMD)

References:

1. https://github.com/keisuke198619/GraphDMD

2. https://github.com/XinweiJiang/VMD
3. https://in.mathworks.com/matlabcentral/fileexchange/72814-multivariate-variational-mode-decomposition-mvmd?s_tid=prof_contriblnk

D. 24AIM344 - Vector databases 3 0 2 4

CO: The student should be able to query and extract relevant information from vector databases.

Introduction to database-Query Language and database management-Indexed search vs Vector search-Introduction to embedding-Tools to develop vector embedding – qdrant, pinecone, Faiss, chromaDB-Chaining in LLM Design. Design and develop a QA system

References:

1. https://courses.edx.org/asset
2. v1:Databricks+LLM101x+2T2023+type@asset+block@Module_2_slides.pdf
3. https://nthu-datalab.github.io/db/slides/20_Vector-DBMS.pdf
4. Toni Taipalus, Vector database management systems: Fundamental concepts, use-cases, and current challenge

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
A	3	3	3	3	1	-	-	-	2	2	-	2	2	1	2
B	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
C	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2
D	3	3	3	2	1	-	-	-	2	2	-	2	2	1	2

Semester VII

24AIM440 - BioMEMS **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- To Make Students Understand the Basic Concepts Of MEMS.
- To Create Problem Solving Ability Among Students for Developing Biological MEMS Design.
- To Encourage Students for Designing Biomems Solutions for Existing Healthcare Solutions.
- To Prepare Students for Entrepreneurship in Biomems Product And Services.

Course Outcomes:

After completing this course, students should be able to

CO1: Analyze and apply microsensors for diverse applications, including acoustic, biological, and chemical sensing.

CO2: Design and analyze various MEMS microactuators, including grippers, motors, valves, pumps, and accelerometers.

CO3: Apply engineering mechanics principles to analyze static bending, mechanical vibrations, thermomechanics, and fracture mechanics in microsystems.

CO4: Demonstrate proficiency in designing microsystems considering material selection, manufacturing processes, signal transduction, and electromechanical systems.

CO5: Evaluate and apply BioMEMS in diverse applications, understanding their role in the micromachines market, biotechnology, and molecular diagnostics.

Syllabus:

Unit 1: Working Principles Of Microsystems Microsensors: Acoustic, Biological, Chemical, Optical, Pressure, Thermal; Microactuations Using Thermal Force, Shape Memory Alloy, Piezoelectric Crystals, Electrostatic Forces; MEMS With Microactuators: Micrograppers, Micromotors, Microvalves, Micropumps; Microaccelerometer.

Unit 2: Engineering Mechanics for Microsystem Design Static Bending Of Thin Plates: Bending Of Circular Plates-Rectangular Plates-Square Plates With Edge Fixed; Mechanical Vibrations: Resonant, Microaccelerometer, Design Theory Of Accelerometer, Resonant Microsensor; Thermomechanics: Thermal Effects On Mechanical Strength Of Materials, Creep Deformation, Thermal Stress; Fracture Mechanics: Stress Intensity Factors, Fracture Toughness, Interfacial Fracture Mechanics; Thin Film Mechanics.

Unit 3: Microsystems Design Considerations: Constraint, Selection Of Materials, Manufacturing Processes, Signal Transduction, Electromechanical System; Process Design: Photolithography, Thin Film Fabrication, Geometry Shaping; Mechanical Designing: Thermomechanical Loading, Stress Analysis, Dynamic Analysis, Fracture Analysis.

Unit 4: Biomems Applications Overall Market Of Micromachines, MEMS In Biotechnology Market, Micro-TAS And LOC In Sample Preparation For Molecular Diagnostics.

References:

1. Hsu, T. R. MEMS and Microsystems: Design and Manufacture, McGraw Hill, 2002.
2. Madou, M. J., Fundamentals of microfabrication and nanotechnology, three-volume set. CRC Press, 2018.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	-	-	-	-	-	2	2	-	2	1	2	2
CO2	3	3	1	-	-	3	-	-	2	2	--	2	-	2	2
CO3	-	-	3	3	2	-	-	-	2	2	-	2	3	2	2
CO4	-	-	2	2	-	-	2	-	2	2	-	2	-	2	2
CO5	-	-	-	-	2	1	2	2	2	2	-	2	-	2	2

24AIM441 - Drug Delivery System **Credits: 3** **Weekly: 2-0-2**

Course Objectives :

- To understand the basics about Drug Delivery system.
- To understand the various ways of drug delivery
- To know about pharmacokinetics and pharmacodynamics.
- To understand the various aspects of Matrix based drug delivery system.

Course Outcomes:

After completing this course, students should be able to
CO1: Understand the fundamental principles of drug delivery systems
CO2: Classify different drug delivery systems
CO3: Analyze the design and characteristics of membrane reservoir systems.
CO4: Gain insights into the pharmacokinetics and pharmacodynamics of drug delivery

Syllabus:

Unit 1: Overview, dosage form-tablet, capsule, parenteral etc. classification of drug delivery system, chemically controlled system, diffusion-controlled system, controlled release mechanism-Membrane reservoir system, Matrix system, swelling controlled release system, biodegradable controlled release system.

Unit 2: Fundamental Aspects of Drug Delivery Introduction of pharmacokinetics and pharmacodynamics, diffusive transport, diffusion in heterogeneous system, passage of drug through membrane drug release kinetics from different biopolymer matrices

Unit 3: Pharmacokinetics Common routes of systemic drug administration, drug absorption, bio-availability, determinants of bio-availability disintegration, dissolution, drug distribution, drug elimination.

Unit 4: Matrix Based Drug Delivery System Delivery materials, polymer-based matrices; hydrogels- drug carriers, transdermal and trans-mucosal drug delivery system, measuring in vitro diffusions, measuring controlled release kinetics, drug targeting approaches, biocompatibility aspects of matrices Immunity and immunological preparations: immunity, types, immunological preparations; bacterial vaccines, vaccines containing living viruses, vaccines containing toxoids Fundamentals of vaccine delivery.

Textbooks / References:

1. Drug Delivery: Fundamentals and Applications, Second Edition. (2016). United States: CRC Press.
2. Drug Delivery: Principles and Applications. (2016). Germany: Wiley.
3. Shargel, L., Yu, A. B. (2016). Applied Biopharmaceutics & Pharmacokinetics, Seventh Edition. Singapore: McGraw-Hill Education.
4. Basic Pharmacokinetics and Pharmacodynamics: An Integrated Textbook and Computer Simulations. (2016). United Kingdom: Wiley

CPO-PO mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	1	1	-	-	-	-	2	2	-	2	3	1	2
CO2	-	-	-	1	-	-	-	-	2	2	-	2	3	1	2
CO3	-	2	-	1	-	-	-	-	2	2	-	2	3	1	2
CO4	-	-	-	1	-	-	-	-	2	2	-	2	3	1	2

24AIM442 - 3D-Printing in Biomedicine **Credits: 3** **Weekly: 2-0-2**

Course Objectives :

- To Make Students Understand The Basic Concepts Of 3D Printing Technology.
- To Create Problem Solving Ability Among Students For Making Their Own 3D Printing Solutions.
- To Encourage Students For Designing Novel 3D Printing Approaches For Different CAD Models.
- To Prepare Students For Entrepreneurship In The Field Of 3D Printing Technology.

Course Outcomes:

After completing this course, students should be able to
CO1: Demonstrate proficiency in CAD design
CO2: Trace the history of digital manufacturing and its evolution
CO3: Evaluate the 3D printing business case
CO4: Investigate 3D printing in various materials.

Syllabus:

Unit 1: Design Process Overview Loading Fusion 360, The CAD Environment, Best Practices For Running CAD, Common CAD Files Types, CAD Libraries; A Short History Of Digital Manufacturing: Design For 3D Print, Fusion 360 Modeling, Sketching, Extruding, Collaborating On Files; Process Flow: Fusion 360 Sculpting, Moving Between Environments, Matching Imported Geometry.

Unit 2: 3DP In Public Media 3 The 3DP Business Case: Working With Meshes, Scanning Tools, Editing Scanned Files, Fixing Scan Bugs; Printing In Plastic: Optimizing For Print, Printing @ Stanford Print, De-Bugging; Printing In Metal: Making Assemblies, Moving And Aligning, Parts Joints.

Unit 3: Bioprinting Approaches Printing In Glass, Wood, Concrete & More: Prototype II, Fasteners, Finishes, Advanced Modeling Tools; Bioprinting: Working With Service Providers, Optimizing Files For Different Methods, Debugging Prints; Politics & Ethics: CAD Rendering, Mechanical Drawings, Photographing Parts.

Unit 4: Different 3D Printing Techniques Stereolithography (SLA), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), Digital Light Process (DLP), Multi Jet Fusion (MJF), Polyjet. Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM).

References:

1. Lipson, H., & Kurman, M. (2013). Fabricated: The new world of 3D printing. John Wiley & Sons. France, A. K. (2013). Make: 3D printing: the essential guide to 3D printers. Maker Media, Inc.
2. Rapid Prototyping Journal (ISSN 1355-2546)
3. International Journal of Rapid Manufacturing (ISSN 1757-8817)
4. Virtual and Physical Prototyping (ISSN 1745-2759)

CO-PO mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	2	1	2	-	3	1	-	-	2	2	-	2	2	2	2
CO2	2	1	2	-	3	1	-	-	2	2	-	2	2	2	2
CO3	2	1	2	-	3	1	-	-	2	2	-	2	2	2	2
CO4	2	1	2	-	3	1	-	-	2	2	-	2	2	2	2

24AIM443 - Embedded and real-time systems **Credit: 3** **Weekly: 2-0-2**

Course Objectives:

- To introduce the basics of embedded systems.
- To introduce the basics of general purpose processors.
- To learn different communication interfaces.
- To learn Embedded / RTOS concepts and different design technologies

Course Outcomes:

After completing this course, students should be able to
CO1: Understand the overview and characteristics of embedded systems
CO2: Analyze the requirements and design challenges associated with embedded systems
CO3: Gain insights into the design technology for embedded systems.
CO4: Explore general-purpose processors, their benefits, basic architecture, and operations.

Syllabus:

Unit 1: Embedded Systems Overview; Characteristics; Components; Categorization; Requirements; Design challenges; Processor technology; IC technology; Design Technology; Processors (RT- level): custom single purpose processor design, combinational logic, sequential logic.

Unit 2: General Purpose Processors Introduction; Benefits; Basic architecture; Operations: Instruction execution, Pipelining; Programmer's view; development environment; Selecting a microprocessor.

Unit 3: Communication Interface Need for communication interfaces, RS232/ RS432 / UART, RS422 / RS485, USB, Infrared, IEEE 1394 Firewire, Ethernet, IEEE 802.11 wireless LAN, Bluetooth.

Unit 4: Embedded / RTOS Concepts and Digital Technology Architecture of the Kernel, Tasks and Task scheduler, Interrupt service routines, Semaphores, Mutex, Timers, Priority inversion problem. Logic synthesis, Behavioral synthesis, System synthesis, Hardware/Software co-design, Hardware/Software co-simulation, Reuse of intellectual property codes.

References:

1. Givargis, T., Vahid, F. (2003). Embedded System Design: A Unified Hardware/Software Introduction. United States: John Wiley & Sons, Incorporated.
2. Fan, X. (2015). Real-Time Embedded Systems: Design Principles and Engineering Practices. Netherlands: Elsevier Science.
3. Kamal, R. (2011). Embedded Systems: Architecture, Programming and Design. India: Tata McGraw Hill Education Private
4. Valvano, J. W. (2011). Embedded Microcomputer Systems: Real Time Interfacing. United States: Cengage Learning.
5. An Embedded Software Primer (With Cd). (1999). India: Pearson Education.
6. IEEE Embedded Systems Letters (ISSN-1943-0663) Journal, Elsevier.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	2	2	-	2	2	2	2
CO2	3	-	3	-	-	-	-	-	2	2	-	2	2	2	2
CO3	3	-	2	-	-	-	-	-	2	2	-	2	2	2	2
CO4	3	-	1	-	-	-	-	-	2	2	-	2	2	2	2

24AIM444 - Healthcare management **Credits: 3** **Weekly: 2-0-2**

Course Objectives:

- Learn concepts and theories in Health Care Management
- Learn to understand perspectives and values of Health Care Management
- Develop the basic management skills and ability to work productively with others
- Develop skills in using materials tools and/or technology central to Health Care Management
- Integrate health care management theory with real world situations

Course Outcomes:

After completing this course, students should be able to
CO1: Define and comprehend the dimensions of health and the philosophy of healthcare management
CO2: Differentiate between leadership and management
CO3: Apply strategic planning tools.
CO4: Examine the history and strategic processes of healthcare marketing.

Syllabus:

Unit 1: An Overview of Healthcare Management, Leadership and Motivation Introduction, Definition and Dimensions of health, Philosophy of Healthcare Management, History and Future of Healthcare Management, Management: Definition, Function, and Competencies, Role of Manager; Leadership vs Management, Leadership Styles, Ethical Responsibility, Motivation, Measuring Engagement, Organizational Behavior and Management Thinking – Four Key Features of Thinking, Socio-Emotional Intelligence, Strategic Planning – SWOT Analysis, Strategy Identification and Selection

Unit 2: Healthcare Marketing, Quality and Information Technology Introduction and History of Healthcare Marketing, Strategic Process, Ethics and Social Responsibility; Quality in Healthcare, Patient-Centered Care, Common Elements of Quality and Improvement, Approaches and Tools for Quality Improvement, Health Information System, Healthcare Information Technology, Financial Management in Healthcare, Controlling Costs, Managing Budget.

Unit 3: Strategic Management of Resources, Teamwork, Law and Ethics Environmental Forces Affecting Human Resources Management, Workforce Planning/ Recruitment, Challenges of Teamwork in Healthcare Organization, Emotions and Teamwork, Organizational Learning, Role of Individuals and Communities in Addressing Health Disparities, Healthcare Law, Malpractices, Ethical Concepts, Rights and Responsibilities of Patient and Provider

Unit 4: Regulation, Compliance and Special Topics Frauds and Abuse, Antitrust Issues, Emergency and Disaster Management, Innovations in Healthcare Management – Global Trends in Health System Innovation, Public Health Innovations, Leapfrog through mHealth, Initiatives by Indian Government, Bioterrorism and Violence in Health Care Settings, Medical Tourism, Consumer-Directed Health Care, Opportunities for Research on Emerging Issues, Case studies.

References:

1. Kite, B. J., Shanks, N. H., Buchbinder, S. B. (2019). Introduction to Health Care Management. United States: Jones & Bartlett Learning, LLC.
2. Singh, V.K., Lillrank, P., Innovations in Healthcare Management: Cost-Effective and Sustainable Solutions. (2015). United States: Taylor & Francis.
3. Amelung, V. E. (2020). Healthcare Management: Managed Care Organisations and Instruments. Germany: Springer Berlin Heidelberg.
4. Dracopolou, S. (2006). Ethics and Values in Healthcare Management. United Kingdom: Taylor & Francis.

CO-PO mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	-	-	-	-	-	1	1	2	2	2	2	2	1	1	1
CO2	-	-	-	-	-	1	1	2	2	2	2	2	1	1	1
CO3	-	2	-	-	-	1	1	2	2	2	2	2	1	1	1
CO4	-	-	-	-	-	1	1	2	2	2	2	2	1	1	1

24AIM445 - Telemedicine **Credits : 3** **Weekly: 2-0-2**

Course Objectives:

- Execute formal training in areas of technology applied to healthcare including computer science and telecommunication technologies to facilitate the deployment of telemedicine.
- Understand the basic requirements for the delivery of telemedicine services.
- Differentiate and apply telemedicine technologies and practices in a variety of health care environments.
- The course will also be committed as a public awareness tool to promote and advocate the use of emerging technologies to expand health care outreach and overcome geographic barriers to deliver patient care and education.

Course Outcomes:

After completing this course, students should be able to

CO1 : Understand the technology computer assisted technology for healthcare.

CO2 : Comprehend the basic requirements for the delivery of telemedicine services.

CO3 : Differentiate and arrange for telemedicine technologies and practices in a variety of health care environments.

Syllabus:

Unit -1: Fundamentals and System of Telemedicine History and Philosophy of TM, Types and Challenges, Standards and Guidelines; TM Systems, Components of TM System, Setting up a TM Facility; TM Workstation and Interfacing Techniques; How Telehealth Services are Reshaping Healthcare; Management of Patient Healthcare Information – EMR, HER, Healthcare Data Analytics, Analytic Approaches; Patient Centered Care

Unit-2: Technology in Telemedicine System TM Technology, Data Transmission - Images, Audio, Video, Time Series Data; DICOM; Cloud Computing, Edge Computing in TM, Types of Telecommunication Technologies, DSL, ADSL; Networking in TM, Network Topologies; Wireless Technologies – WiMAX, ZigBee etc., Evolution of Mobile Networks 1G – 5G; Mobile Health; Applications of Emerging Technologies in TM like 3D Printing, AR/ VR, Blockchain, Big Data Analytics, IoT etc., Connected Health, Digital Health.

Unit-3: Tele-home Care and Telehealth Categories, Technologies, Requirements for Tele-home Care, Tele-home care for Chronic Disease Management; Personal Health Monitors, Point-of-Care Testing Instrument, Intelligent Biomedical Clothes, Wearable Monitors; eHealth and Cybermedicine, Internet and Telemedicine, Videoconferencing Systems and Multimedia Data Exchange.

Unit-4: Ethical, Privacy, Security, Legal, Standards and other Issues Maintaining and Sustaining a Telehealth-based Ecosystem, Tele education for Health workers, Ethical Issues, Cyber Laws, Legal Issues, TM for low resource settings, Data Protection Laws of Indian Government, ISO standards, WHO Medical Device Regulations, USFDA standards for Healthcare

References:

1. Khandpur, R. S. (2017). Telemedicine: Technology and Applications (mHealth, TeleHealth and EHealth). India: PHI Learning.
2. Balas, V. E. (2019). Telemedicine Technologies: Big Data, Deep Learning, Robotics, Mobile and Remote Applications for Global Healthcare. United Kingdom: Elsevier Science.
3. https://medicalfuturist.com/

CO-PO mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	2	1	2	-	-	-	2	2	-	2	2	2	2
CO2	-	-	-	1	2	-	-	-	2	2	-	2	2	2	2
CO3	-	2	-	1	2	-	-	-	2	2	-	2	2	2	2

24AIM446 – Basic Clinical Science **Credits : 3** **Weekly: 2-0-2**

Course Objectives:

- To understand physiology and pathology of the cardiac system.
- To understand the normal and abnormal ECG along with their interpretation.
- To study about orthopedics and fracture management.
- To know about joints and their diseases.

Course Outcomes:

After completing this course, students should be able to
CO1 : Comprehend the basic physiology and pathology of the cardiac system.
CO2 : Analyse the symptomatic signatures in ECG and their interpretation.
CO3 : Identify clinical basic problems in joints and orthopaedics issues.

Syllabus:

Unit-1: Cardiac System Heart structure and function. Cardiac cycle. Various valves and their functions. IABP. Cardiovascular measurements. Heart lung machine. Applications. Clinical significance. CVP and SWAN Catheters.

Unit-2: Electrocardiogram and Interpretation Electrocardiography: Sources of ECG potentials. Dipole theory. Conduction system. Normal and abnormal ECGs. Diagnostic applications. Interpretation of ECG. Cardiac pacing. Diagnostic indications. Criteria for selection. Therapeutic indications. Complications. Pacemaker. Temporary pacing. Permanent pacing.

Unit-3: Orthopedics and Fracture Bioengineering Orthopedics & Fracture Bioengineering aspects of fracture management. Structure of bone: gross, microscopic biochemical. Fracture-types mechanism of injury. Normal healing of fractures. Pieze electricity and electrical stimulation for bone healing. Treatment of fractures-general principles –closed methods. External fixation and internal fixation. Biomechanics of internal fixation and description of external fixators. Bioengineering principles of internal fixation. Intra medullary nails. Plates, screws. The concepts of load hearing and load sharing and shielding by implants.

Unit-4: Joints and Disease Joints bioengineering aspects of joint diseases. Structure of joints – fibrous, cartilaginous, synovial. Lubrication of joints and the function of articular cartilage. Degeneration of cartilage degenerative arthritis and rheumatoid arthritis. Joint replacement, hip, knee, shoulder, small joints.

References:

1. Rushmer, R. F. (1967). Cardiovascular Dynamics. United Kingdom: W.B. Saunders.
2. Frankel, V. H., Nordin, M. (2012). Basic Biomechanics of the Musculoskeletal System. United Kingdom: Lippincott Williams & Wilkins.
3. Maheshwari, J., Mhaskar, V. A. (2019). Essential Orthopaedics: (including Clinical Methods). India: Jaypee Brothers,Medical Publishers Pvt. Limited.
4. Hall, J. E. (2020). Guyton and Hall Textbook of Medical Physiology. United States: Elsevier.
5. Grant, A. W., Grant, A., Waugh, A. (2006). Ross and Wilson Anatomy and Physiology in Health and Illness. United Kingdom: Churchill Livingstone.

CO-PO mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	2	1	1	-	-	-	2	2	-	2	1	1	2
CO2	-	-	-	1	1	-	-	-	2	2	-	2	1	1	2
CO3	-	2	-	1	1	-	-	-	2	2	-	2	1	1	2

Course Objectives:

- The objective of the course is to familiarize the students with microorganisms and viruses, their structures, diseases caused by bacteria and viruses and their control.
- Another objective is to introduce and elaborate upon the various aspects and mechanisms of immunity

Course Outcomes:

After completing this course, students should be able to

CO1: Understand the basic microbial & viral structure and function and comparative characteristics of prokaryotes and eukaryotes.

CO2: Understand the processes in microorganisms and viruses for their replication, survival, and interaction with their environment, hosts, and host populations

CO3: Understand fundamentals of microbe/viral interaction with humans leading to pathological effects

Syllabus:

Microbiology and pathology i) History of microbiology, General Pathology – history and principles of pathology, Microscopic pathology Bacterial and Viral Pathology – i) General structure of bacteria and virus ii) Mechanism of bacterial and viral pathogenesis – an overview iii) Bacterial pathogens and the diseases – Staphylococcus, Streptococcus, Neisseria, Enterobacteriaceae (Escherichia, Klebsiella, Enterobacter, Proteus, Salmonella and Shigella). Campylobacter, Helicobacter. Vibro cholera, Clostridia (spore-forming anaerobic bacteria), Pseudomonas, Mycobacteria. Brucella, Hemophilus species, Treponema, Leptospira, Legionella, Chlamydia and mycoplasmas iv) Basic Pathogenesis of specific virus families' relevance to human diseases – Coronaviridae, Adenoviridae, Hepadnaviridae, Herpesviridae, Reoviridae, Retorviridae, Orthomyxoviridae, Paramyxoviridae, Papillomaviridae, Picornaviridae & Togaviridae Fungal Pathology – i) classification, structure, and function of fungi, fungal pathogenesis, and the host response to fungal infections, including aspergillosis, candidiasis, and cryptococcosis. Parasitic Pathology - i) classification, parasitic pathogenesis, and the host response to parasitic infections. Major medically important protozoa and associate diseases – Leishmania, Plasmodium malaria, Toxoplasma gondii, Trichomonas vaginalis, Trypanosomes, Entamobea histolytica. ii) Emerging Infectious Diseases: recent advances in the understanding of newly emerging infectious diseases, including SARS, MERS, and COVID-19.

Immunology/Immuno-pathology i) Introduction to Immunology, structure and function of Immune system ii) Innate Immunity: Toll-like receptors, complement system, phagocytosis. iii) Acquired Immunity: T and B cell immunity, humoral and cell-mediated immunity, antibody structure and function. Passive Immunity and immune evasion strategies. iv) Antigens and Antigen Presentation: antigen processing and presentation, Major Histocompatibility Complex (MHC) molecules, T cell receptor (TCR) structure and function. General structure of antibodies, antigen- antibody reactions. v) Immune Tolerance: central and peripheral tolerance, self-tolerance mechanisms, regulatory T cells. vi) Immunological Disorders: autoimmune diseases, immune-deficiencies and allergies – including mechanisms of allergy, type 1 hypersensitivity reactions, atopic diseases and food allergies. vii) Vaccines: Types of vaccines, vaccine development and production, vaccine efficacy and safety. viii) Immunotherapy – cancer and infectious diseases. Immunotherapy in combination with chemotherapy, radiation therapy or targeted therapy. ix) Transplantation Immunology: mechanisms of transplant rejection, tolerance induction, and immunosuppression.

References:

1. Microbiology: An introduction, G.J. Tortora, B.R. Funke, C.L. Case, 5th Edition, Benjamin Pub. Co. NY, 1992.
2. Medical Bacteriology, N.C. Dey, and T. K. Dey, Allied Agency, Calcutta, 17th Edition, 1988.
3. Text book of microbiology, R. Ananthnarayana, and C.E, Jayaram Panikar, 5th edition, Orient Longman, 1996.
4. Fields Virology D. Knipe and P. Howley. Vol.1 and 2- 4 th Edition. Lippincott-Raven Publishers, 2006. 5) Fundamentals of Molecular Virology, N. H. Acheson 2nd Edition. Wiley Publisher, 2011.
5. Title: Medical Microbiology. Authors - Patrick R. Murray, Ken S. Rosenthal, and Michael A. Pfaller. 9th edition, 2020, Publisher – Elsevier. ISBN - 9780323673228.
6. Title: Medical Microbiology. Authors - David Greenwood, Richard CD., Slack, John Forrest Peutherer. 16th edition,1992. ELBS with Churchill Livingstone.
7. Title: Clinical Immunology: Principles and Practice. Authors - Robert R. Rich, Thomas A. Fleisher, William T. Shearer, Henry M. Lederman, Michael F. Fanger, and Annette L. Baumeister. 3rd edition, 2018. Publisher – Elsevier. ISBN: 9780323552071.
8. Title: Kuby Immunology. Authors: Judy Owen, Jenni Punt, and Sharon Stranford. 8th edition, 2018; Publisher: W. H. Freeman and Company. ISBN: 978-1319114701.
9. Title: Underwood's Pathology: A Clinical Approach. Author: Simon Cross. Edition: 6th, 2017; Publisher: Churchill Livingstone. ISBN: 9780702051348
10. Title: Rapid Review Pathology. Author: Edward F. Goljan. 4th edition, 2019. Publisher: Elsevier. ISBN: 9780323528707

CO-PO mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	-	-	2	1	-	-	-	-	2	2	-	2	1	1	2
CO2	-	-	-	1	-	-	-	-	2	2	-	2	1	1	2
CO3	-	2	-	1	-	-	-	-	2	2	-	2	1	1	2

24AIM448 Nano, novel & alternative medicine approaches Credits: 3 Weekly: 2-0-2

Course Objectives:

- The course aims to introduce basic ideas and terms in nanomedicine.
- The students shall be exposed to novel developments in medicine
- Another objective is to introduce and elaborate upon the various marginalized approaches to medical therapy

Course Outcomes:

After completing this course, students should be able to
CO1: Design nanomedicines of various types and preparation methods of nanomedicines
CO2: Identify specific features of nanomedicines and their ways of action and complications thereof
CO3: Conceptualize the various alternative medicine approaches and the problems therein

Syllabus:

Unit 1: Nanomedicine: Basic concepts in the design of nanomedicine, specification and desired features of nanomedicine, nanomaterials and general process steps involved in the preparation of nanomedicines. Nanomedicines for various disease conditions: infectious diseases, neurological diseases: (challenges of blood brain barrier), pulmonary disorders, cardiovascular diseases, cancer: nano-chemotherapy, Theranostic nanomedicines: Basic concept, multifunctional nanomedicines for theranosis.

Unit 2: Radiation therapy, immunotherapy, nuclear medicine therapy, photodynamic therapy, photothermal and RF hyperthermia therapy, scintillation therapy, gene-therapy: DNA, RNA delivery.

Unit 3: Homeopathy, Acupuncture/Acupressure, Ayurveda, Hypnosis, Body manipulations, etc. Basic ideas on theorization and practice… issues and questions.

References:

1. Nanomedicine for Cancer Therapy: From Chemotherapeutic to Hyperthermia-Based Therapy , Springer, Piyush Kumar, RohitSrivastava, 2017
2. Nanotoxicology, Materials, Methodologies, and Assessments, Editors: Durán, Nelson, Guterres, Silvia S., Alves, OswaldoLuiz (Eds.),
3. https://www.ncbi.nlm.nih.gov/books/NBK538520/

CO-PO mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	2	1	-	-	-	-	2	2	-	2	3	1	2
CO2	-	-	-	1	-	-	-	-	2	2	-	2	3	1	2
CO3	-	2	-	1	-	-	-	-	2	2	-	2	3	1	2

24CSE431 Advanced Database Management Systems Credits: 3 Weekly 2-0-2

Pre-requisite

Student should have done basic database management systems

Learning Objectives

The course envisages to create

- understanding of the limitations of relational database systems
- theoretical understanding, ability to design and realize a nosql database in distributed platforms

Course Outcomes

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

CO1 : Compare different NoSQL databases

CO2 : Identify the suitable NoSQL database for a specific application

CO3 : Design key-value, document oriented and graph databases in distributed manner

CO4 : Explain the theoretical motivation behind NoSQL databases

Syllabus

Unit 1

Distribution Models; Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication – Availability and Fault Tolerance - Data Consistency Models-ACID, BASE models, CAP theorem, Concurrency Control– NoSQL databases-types of NoSQL databases, NoSQL system ways to handle big data problems: Moving Queries to data, not data to the query,

Unit 2

Key-value databases

From array to key –value databases, Essential features of key – value Databases, Properties of keys, Characteristics of Values, Key-Value Database Data Modeling Terms, Key-Value

Architecture and implementation Terms, Designing Structured Values, Limitations of KeyValue Databases, Design Patterns for Key-Value Databases, Case Study: Redis database

Unit 3

Document Oriented Databases

Document, Collection, Naming, CRUD operation, querying, indexing, Replication, Sharding,

Consistency Implementation: Distributed consistency, Eventual Consistency, Capped Collection,

Case studies: document oriented database: MongoDB

Unit 4

Graph Databases

What Is a Graph Database? Comparison with relational modeling,Graph Databases, Consistency, Transactions, Availability, Query Features, Scaling, Use Case : Neo4J

References:

1. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of

Polyglot Persistence, Wiley Publications,1st Edition ,2019

2. Guy Harrison, Next Generation Databases: NoSQLand Big Data, Apress, 2015

CO & PO mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	3	-	-	-	2	2	-	2	2	1	-
CO2	3	2	2	-	3	-	-	-	2	2	-	2	2	1	-
CO3	3	2	2	-	3	-	-	-	2	2	-	2	2	1	-
CO4	3	3	3	-	-	-	-	-	2	2	-	2	1	1	-

24CSE432 Computer Graphics Credits: 3 Weekly 2-0-2

Course Objectives:

The course imparts the know-how of design and implement a basic computer graphics system. The student should is introduced to the basics of animation systems such as drawing the basic geometrical structures that form the primitive components of more complex graphic visualization. The student also is given an introduction to OpenGL primitives so as to enable realization of complex graphical systems.

Course Outcomes:

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

CO1 : Implement basic graphic modeling algorithms such as primitive shape drawing to clipping of 2D shapes

CO2: Mathematically represent the transformations

CO3 : Realize graphical models of solids, scenes with realistic illumination effects

CO4 : Implement all the techniques learned in OpenGL

Introduction : Basics, applications and scope, Graphics standards, Interaction (sample- and event-driven) and Graphics user Interface (GUI) features.

Display Systems Raster refresh displays, CRT basics, video basics, Flat panel displays.

Geometric Modeling : Drawing lines, curves, polygons,Surfaces (Bezier curves and surfaces, B spline curves and surfaces), Area filling, Anti-aliasing, Clipping algorithms - Chen-Sutherland Line Clipping, Mid-point subdivision algorithm, Liang-Barsky clipping, Cyrus-Beck line clipping, Polygon Clipping: Sutherland-Hodgeman and Weiler-Atherton polygon clipping

Transformations : Affine (2-D and 3-D): Rotation, Translation, Scale, Reflection and Shear; Viewing: The Camera Transformations - perspective, orthographic, isometric and stereographic views, Viewing pipeline; Camera Models and multi-view generation.

Solid Modeling : Wire-frame, Octrees, Sweep, Boundary representations. Regularized Boolean set operations, Constructive Solid Geometry (CSG); Hierarchical Scene and Object graphs, Scene Description.

Hidden Surface Removal : Back face detection, Z-buffer method, Painter's algorithm, scan-line algorithm, BSP-trees, Area sub-division method, Ray tracing.

Illumination models and surface rendering: Basic illumination models, Half-toning and dithering techniques, Polygon Rendering, Color models

OpenGL primitives : Functions, pipeline, sample programs for drawing 2-D, 3-D objects; event handling and view manipulation.

References :

1. Steve Marschner & Peter Shirley, Fundamentals of Computer Graphics, 4th edition.

2. Computer Graphics; Principles and practice; Second Edition in C; J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes; Addison Wesley, 1997.

3. Computer Graphics - C version; D. Hearn and M. P. Baker; Pearson Education, 2004.

4. Computer Graphics - OpenGL version; D. Hearn and M. P. Baker; Pearson Education.

CO & PO mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	3	-	-	-	2	2	-	2	2	-	-
CO2	3	2	2	-	3	-	-	-	2	2	-	2	2	-	-
CO3	3	2	2	-	3	-	-	-	2	2	-	2	2	-	-
CO4	3	3	3	-	-	-	-	-	2	2	-	2	1	-	-

24CSE433 Distributed Computational Systems. Credits: 3 Weekly 2-0-2

Objectives

The course introduces the basic principles governing the design and implementation of various schemes in developing a distributed computing system.

The course aims to provide provide practical insights to various methedologies involved in distributed systems.

Course Outcomes

CO1 :Explain the design principles governing distributed systems.

CO2 :Implement the various communication algorithms in distributed algorithms.

CO3:Analyze the various resource management schemes in distributed environment.

CO4:Evaluate the issues involved in distributed data management.

Unit 1

Introduction to Distributed Systems,Distributed System Architecture,Networking – Layering, Switching,Routing, Congestion Control.Inter-Process Communication –Socket, RPC, Message-passing and multi-cast.

Unit 2

Logical Time -Basic properties, types .Implementation of vector clocks. Global state and snapshots-Chandys Lamport Algorithm,Non-FIFO channels.Distributed mutual exclusion-Lamports algorithm.Deadlock detection -Models.Termination detection-system model.

Unit 3

Distributed file systems – replica management ,concurrency control,load balancing.Fault tolerance – models,committ protocols,voting protocols.Consensus problem.Self-stabilization - defenition,issues.

Texts

1.Andrew S. Tannenbaum and Maarten van Steen, Distributed Systems: Principles and Paradigms, Third Edition,
Prentice Hall, 2017.

2.Ajay D. Kshemkalyani and Mukesh Singhal, Distributed Computing: Principles, Algorithms, and Systems, CambridgeUniversity Press, 2011.

References

1.Garg VK, Garg VK. Elements of distributed computing. John Wiley & Sons; 2002.

2.George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, Distributed Systems: Concepts and Design, Fifth Edition, Pearson Education, 2017.

CO & PO mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	3	-	-	-	2	2	-	2	2	1	-
CO2	3	2	2	-	3	-	-	-	2	2	-	2	2	1	-
CO3	3	2	2	-	3	-	-	-	2	2	-	2	2	1	-
CO4	3	3	3	-	-	-	-	-	2	2	-	2	1	1	-

24RAI431 Sensors and Actuators for Robotics Credits: 3 Weekly: 2-0-2

Course Objectives:

- The course aims to give a reasonable understanding of the principles and operations of sensors and actuators for robotics
- The course helps with the selection of sensors and actuators for the robot based on the application

Course Outcomes:

After completing this course, students will be able to:

CO1: Distinguish the different classes of sensors and actuators suitable for robotics application

CO2: Analyze the principle of operation of different sensors and actuators used in robotics application CO3: Design sensors and actuators for robotics applications with easy implementation and cost-effectiveness.

CO4: Identify the best sensor and actuator for accomplishing the work with accuracy, convenient operating features, and great functionality.

Syllabus

Sensors for robots: Sensor classification and characteristics, Touch and proximity sensors: IR, Photodiodes. Tactile sensors, collision sensors, interaction sensors – proximity/distance sensors, Position measurement: Optical encoder, Potentiometer, 2D and 3D cameras, Velocity measurement. Inertial sensors: Gyroscopes, Accelerometer. Force sensors, Torque sensors. Range sensors: IR, Ultrasonic sensors, laser ranger finder. Robot actuators: Hydraulic actuators, Pneumatic Actuator, Electrical actuator, Introduction to motors: DC motors, AC motors, Stepping motors, Servo motors. Motion transmission: Gear transmission, Belt transmission. Harmonic drive.

Text Books / References

Sensors, Actuators, and Their Interfaces: A multidisciplinary introduction, 2nd edition. Nathan Ida, 2020.

Industrial Robotics: Technology Programming and Applications, 2nd Edn, Mikell P Groover, Tata McGraw Hill Education Private Limited, 2012.

John J Craig, Introduction to Robotics, Mechanics and control, second edition Addison – Wesley, 1999.

Robert J Schilling: Fundamentals of Robotics, Analysis and Control. Prentice Hall of India, 1996.
http://www.societyofrobots.com/robot_tutorial.sh tml#sensors
http://www.sensorcentral.com/photoelectric/ultra sonic01.php

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	-	3	-	-	-	3	3	-	1	1	-	3
CO2	3	1	1	-	3	-	-	-	3	3	-	1	1	-	3
CO3	3	2	3	1	3	2	1	1	3	3	-	1	1	-	3
CO4	3	3	3	2	3	2	1	1	3	3	-	1	1	-	3

Course Objectives:

1. To enable learners to apply mathematics in the design of under-actuated robotic systems with a primary emphasis on linear quadratic regulator based predictive control and state estimation

2. To train the students in applying the idea of optimal control to the design of under-actuated robotic control

Course Outcomes:

After completing this course, students will be able to:

CO1: Analyze nonlinear underactuated systems

CO2: Demonstrate simple robot models for walking and running

CO3: Simulate the dynamics and control of Highly articulated robots

CO4: Perform nonlinear planning and control of simple robot models

UNIT – I

Fully actuated vs Under-actuated Systems

Motivation and Definition of under-actuated control problem-Input and output state constraints- Non-holonomic Constraints-Case studies examples- simple pendulum-Humanoid robot, UAV and wheeled robots- Introduction to optimal control-Double-integrator examples

UNIT – II

Model Based Control

Pendulum case study-Nonlinear dynamics with constant torque-Equations of motion-Linearizing the manipulator equations-Controllability Factor-Linear Quadratic regulator (Hamilton-Jacobi-Bellman (HJB) sufficiency), Pontryagin's min-time control

UNIT – III

Nonlinear Planning & Control-1

Formulating control design as an optimization-Continuous dynamic programming-HJB equation- Solving for minimizing control-Stabilization of nonlinear systems- Finite horizon control -Linear quadratic optimal tracking-LQR with input and output constraints- LQR as a convex optimization problem- LQG-Case studies-Pendulum

UNIT – IV

Nonlinear Planning & Control-2

Lyapunov functions-Relationships to HJB equations-Lyapunov analysis for linear and polynomial systems-Trajectory optimization problem- Feedback motion planning-Linear Quadratic Gaussian approach- Model predictive control approach

REFERENCES

1. Brian D. O. Anderson and John B. Moore. Optimal Control: Linear Quadratic Methods. Dover Publications, 1st Edition, 2007.

2. Bertsekas, Dimitri P. Dynamic Programming and Optimal Control. 3rd ed. Vols. I and II. Nashua, NH: Athena Scientific, 2007. ISBN: 9781886529083 (set).

3. Donald.E.Kirk. Optimal Control Theory, Dover Publications,2004

4. Fantoni, Isabelle, and Rogelio Lozano. Non-linear Control for Under-actuated Mechanical Systems. New York, NY: Springer-Verlag, 2002. ISBN: 9781852334239.

5. Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Boulder, CO: Westview Press, 2001. ISBN: 9780738204536.

6. Slotine, Jean-Jacques E., and Weiping Li. Applied Nonlinear Control. Upper SaddleRiver, NJ: Prentice Hall, 1991. ISBN: 9780130408907

ONLINE MATERIAL

1. MIT open course ware: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-832-underactuated-robotics-spring-2009/index.htm

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	-	-	-	3	3	-	2	3	-	2
CO2	3	3	1	1	3	1	-	-	3	3	-	1	2	1	3
CO3	3	3	3	2	3	1	-	-	3	3	-	2	3	2	3
CO4	3	3	3	2	3	-	-	-	3	3	-	2	3	1	3

Course Objectives:

- To enable learners to understand and analyse the robotics algorithms that solves tasks such as path planning, robot control and robot learning
- Acquire knowledge to design multi-robot systems with precise control and stability

Course Outcomes:

After completing this course, students should be able to

- Demonstrate an understanding of different types of architectures in multi robot systems and introduction to swarm robots.
- Analyse the different algorithms which are involved in multi-robot systems
- Explain mathematical concepts involved in the study of control and study different stability techniques
- Design control algorithms for multi robot systems

UNIT – I

Multi Robot Systems & Algorithms

Introduction to multi robot systems, Architectures of Multi Robot Systems (MRS), Swarm Intelligent Optimization Algorithms and its applications in mobile robot path planning, Leader-Follower Algorithm, and Time varying algorithm for Swarm Robots, A minimalist flocking algorithm. Formation and Obstacle Avoidance in the Unknown Environment of Multi-Robot System. A navigation Algorithm for swarm navigation.

UNIT – II

Multi-Robot Systems - Control and Stability

Introduction, Model predictive control (MPC), Dynamic Matrix Control (DMC), Adaptive Steering and Trajectory Control of Wheeled Mobile Robots for Autonomous Navigation. Aerial robot formation control via pigeon –inspired Optimization. Distributed control of robot Swarms: A Lyapunov - like Barrier Functions Approach. Adaptive Swarm Coordination and Formation Control.

UNIT – III

Applications & case studies

Foraging and Coverage, Flocking and Formations, Box Pushing and Cooperative Manipulation, Multi-target Observation, Traffic Control and Multi-robot Path Planning, Soccer, case study: Cockroach Inspired shelter seeking for Holonomic swarms for flying robots.

TEXT BOOKS

1. Ying Tan, *Handbook of Research on Design, Control, and Modelling of Swarm Robotics Advances in Computational Intelligence and Robotics*, IGI Global, 1st Edition, 2015

REFERENCES

1. Mariam Al-Sagban, Rached Dhaouadi, *Adaptive Steering and Trajectory Control of Wheeled Mobile Robots for Autonomous Navigation*, Intech open, 1st Edition, 2016
2. Kuppan Chetty RM, Singaperumal M, Nagarajan T: *Cooperative Formation Planning and Control of Multiple Mobile Robots,* Intech open, 1st Edition, 2011
3. Tao Zhang, Xiaqin Li, Yi Zhu, Song Chen, Yu Cheng, Jingyan Song: *Formation and Obstacle Avoidance in the Unknown Environment of Multi-Robot System*, Intech open, 1st Edition, 2011

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	-	-	-	3	3	-	2	3	-	2
CO2	3	3	1	1	3	1	-	-	3	3	-	1	2	1	3
CO3	3	3	3	2	3	1	-	-	3	3	-	2	3	2	3
CO4	3	3	3	2	3	-	-	-	3	3	-	2	3	1	3

Course Objectives:

- To provide an introductory understanding on robotic operating system and gazebo simulation environment.
- To introduce the students with module developments in ROS for mobile robot control, navigation and environment mapping.
- To introduce the students with module developments in ROS for industrial robot control, path planning and trajectory planning.

Course Outcomes:

Upon completion of the course, students will be able to

CO1: Apply the principles of ROS for module development of robotic systems.

CO2: Analyse various robotic systems using ROS integrated simulation platforms.

CO3: Apply the knowledge of robotic system and ROS for mobile robot control, navigation and environment mapping using ROS simulators.

CO4: Develop prototypical robotic systems using ROS for real-time problems

Syllabus

ROS concepts - Preliminaries – Publishing a topic – Subscribing to a topic – Latched topics – Defining message types – Mixing Publishers and subscribers – Services – Defining a service – Implementing a service – Using a service – Actions – Definition of an Action – Implementing a basic action server – Robots model and Simulators – Sub systems – Actuation: Mobile platform – Actuation manipulator arm – Cameras and Scanners – Wheeled Mobile Robot Navigation and Control

Text Books / Reference Books

Joseph, Lentin, and Jonathan Cacace. Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System. Packt Publishing Ltd, 2018.

Programing Robots with ROS', M. Quigley, B. Gerkey, and W. D. Smart, Oreilly Publishers, 2015.

Koubâa, Anis, ed. Robot Operating System (ROS). Vol. 1. Cham: Springer, 2017.

'ROS Robotics by example', Fairchild & Harman, PACKT Publishing, 2016

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	1	3	2	-	-	3	3	-	2	2	3	2
CO2	3	2	1	2	3	2	-	-	3	3	-	-	2	3	2
CO3	3	2	3	2	3	-	3	3	3	3	3	2	2	3	2
CO4	3	2	3	2	3	-	3	3	3	3	3	2	2	3	2

Course Objectives:

- The course aims to give a reasonable understanding of the principles and operations of electromagnetic wave propagation in unbounded medium
- This course also formulates the strategies to describe the characteristics of communication systems particularly under radio wave frequencies

Course Outcomes:

After completing this course, students will be able to:

CO1: Analyse the wave propagation in unbounded medium

CO2: Explore the radiation pattern of short dipole antennas, point sources, wire antennas, and array antennas from the formulation of the fundamental antenna parameters and hence to design the practical antennas in the low frequency, medium frequency and high frequency regimes

CO3: Familiarize various analog modulation & demodulation techniques, functioning of transmitters and receivers.

CO4: Familiarize the various techniques used for designing the elements of digital communication system

Syllabus

Unit-I **Electromagnetic Wave Propagation**

Introduction – Review of Vectors– Faraday's Laws of Electromagnetic Induction – Displacement Current – Maxwell's Equations – Electromagnetic Boundary Conditions - General Wave Equations – Wave Propagation in Lossy Dielectrics and in Lossless Dielectrics – Free Space Wave Propagation- Polarization of a Wave – Linear, Elliptical and Circular Polarization – Introduction to transmission lines and waveguides.

Unit-II **Radiation Elements & Antenna Fundamentals**

Definition of antenna – antenna as oscillating dipole –Retarded fields – Retarded potentials –Radiation from a short dipole – Power radiation by point source – Radiation resistance – Radiation patterns – Reciprocity theorem and Friis formula – Directivity – Gain and aperture concept – Antenna Arrays – Practical Antennas: Yagi Uda – Helical – Patch.

Unit-III **Analog Communication Systems**

Modulation and its types – Amplitude Modulation – Modulation Index – Spectrum – Generation and detection of AM waves – Angle Modulation – Generation and detection methods – AM transmitters & Receivers – FM Transmitters and Receivers.

Unit-III **Digital Communication Systems**

Introduction to Digital Communication – sources and signals – Basic signal processing operations in Digital Communication - Sampling and Quantization – Sampling theorem – Impulse train sampling– Natural sampling–Flat-top sampling – Reconstruction of message from its samples through interpolation function – Introduction to pulse code modulation – Uniform and Non uniform quantization –Signal to noise ratio of quantized pulse – Companding (A-law and μ-law), PCM waveform types. Introduction to baseband and band pass transmission.

Text Books / References

1. Matthew N.O.Sadiku*, Principles of Electromagnetics,* 4th Edition, Oxford University Press, New York, 2007.
2. Simon Haykin, Communication Systems, 5th Edition, Wiley India, 2009.
3. Taub and Schilling, Principles of Communication Systems, 3rdEdition, McGraw Hill, 2008.
4. Wayne Tomasi, Electronic communication systems, 4th Edition, Pearson Education Asia, 2006.
5. Edward C. Jordan and K.G.Balmain. Electromagnetic waves and radiating systems, 2nd Edition, PHI, 2009.
6. John D. Kraus. Antennas for all applications, 3rd Edition, Tata Mcgraw-Hill, 2008.
7. B. Sklar. Digital Communication – Fundamentals and Application, 2nd Edition, Pearson education India, 2009.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	-	3	-	-	-	3	3	-	1	1	-	3
CO2	3	1	1	-	3	-	-	-	3	3	-	1	1	-	3
CO3	3	2	3	1	3	2	1	1	3	3	-	1	1	-	3
CO4	3	3	3	2	3	2	1	1	3	3	-	1	1	-	3

24ECE432 Analog Circuits Credits: 3 Weekly: 2-0-2

Course Objectives:

To enable the learners to design stable biasing circuits, depict BJT, JFET & MOSFET and apply models to design and analyse amplifier / oscillator circuits.

Course Outcomes:

After completing this course, students will be able to:

CO1: Design a stable biasing circuit for transistors

CO2: Understand and design different amplifier circuits using BJT, FET, and MOSFET

CO3: Analyze the effect of feedback in the transistor circuits

CO4: Familiarize the various power amplifier circuits and its efficacy

UNIT – I

Review of characteristics of BJT, JFET & MOSFET– Selection of Operating Point for BJT- DC Load Line – **BJT:** Types of Biasing (Fixed, Emitter Feedback, Collector Feedback & Voltage Divider) – Bias Stabilization – Bias compensation – **JFET**: Types of Biasing (Gate, Self, Voltage Divider, Source & Current Source) – **MOSFET:** Types of Biasing (Drain Feedback & Voltage Divider).

UNIT – II

BJT Amplifiers: Small Signal Analysis: Classifications of Amplifier - **JFET Amplifiers:** Small Signal Model: Common Source – Common Drain – Common Gate.

MOSFET Amplifiers: Small Signal Parameters, Small Signal Equivalent Circuit – Common Source Amplifier – Common Drain Amplifier.

UNIT – III

Effect of positive and negative feedback on amplifiers – Feedback connection types – Feedback amplifiers – Merits and demerits.

Oscillators-principle of operation – Phase shift – Wein Bridge – Crystal – LC Oscillators using BJT-UJT Relaxation Oscillator.

Multivibrators: Astable, Monostable & Bistable (Principle of Operation Only).

UNIT – IV **15 Periods**

Power Amplifiers: Working Principle of Class A, Class AB, Class B, Class C, Class D and Class S amplifiers - Efficiency of Class A, B and C amplifiers.

REFERENCES

1. Richard C. Jaeger, Travis N. Blalock, *Microelectronic Circuit Design,* 5th Edition, McGraw Hill, 2016.
2. Donald A Neamen, *Electronic Circuit Design and Analysis,* 3rd Edition, McGraw Hill Education, 2014.
3. Robert L. Boylestad & Lousis Nashelsky, *Electronic devices & Circuit Theory,* 10th Edition, Pearson education, 2009.
4. Jacob Millman, Christos C. Halkias, Satyabrata Jit, *Electronic Devices and Circuits,* 4thEdition, McGraw Hill Education, 2015.
5. S. Salivahanan, N. Suresh Kumar, A. Vallavaraj, *Electronic Devices and Circuits,* 2ndEdition, Tata McGraw Hill Education, 2011.

ONLINE MATERIAL

NPTEL – http://www.youtube.com/playlist?list=PL4C141B35706AD19A

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	-	-	-	3	3	-	2	3	-	2
CO2	3	3	1	1	3	1	-	-	3	3	-	1	2	1	3
CO3	3	3	3	2	3	1	-	-	3	3	-	2	3	2	3
CO4	3	3	3	2	3	-	-	-	3	3	-	2	3	1	3

Course Objectives:

- to represent any arbitrary signals in time and frequency domains and design LTI systems with specific impulse / step responses
- Introduce the basic concepts of control system, its types, transfer function and state space models
- To analyse the linear time invariant system in time and frequency domains and also to find the system specification in both the domains

Course Outcomes:

After completing this course, students should be able to

- Design and test CT / DT LTI systems in both the time and frequency domains
- Apply unit impulse function and basic complex exponentials for system analysis
- Design a control system for a linear time invariant, single input and single output system
- Evaluate the time and frequency responses of the systems

UNIT – I

Introduction to signals and systems

Signals: Definition - Classification of signals : Continuous time – Discrete time – Deterministic & Random - Periodic & Non-periodic - Even & odd - Energy & Power signals – Basic operations on Independent Variable: Time Shifting -Time scaling - Time Reflection – Basic operations on Dependent Variable: Amplitude scaling, Addition, Multiplication, Differentiation and Integration - Basic elementary signals: Complex exponentials & sinusoidal – unit impulse – unit step – unit ramp.

Systems: Definition - Classification of systems: Continuous time – Discrete time systems – Basic system properties: Linearity – Time invariance – Memory and Memory less - Causality – Invertibility and Inverse – Stability.

UNIT – II

Linear Time Invariant Systems

Representation of discrete & continuous time signals in terms of impulses – Convolution sum – Convolution integral – Properties of convolution: Commutative, Associative and Distributive – Properties of LTI systems: Memory and Memory less – Invertibility – Causality – Stability – Unit step response of an LTI systems - Casual LTI systems described by Differential & Difference equations.

Sampling: Sampling theorem, Definition of CTFT and inverse CTFT, Definition of DTFT and inverse DTFT, Definition of Z transform- Region of convergence – Inverse Z transform (Partial fraction method)

UNIT – III

Basic Concepts of Control System

Introduction: Definition of system, control system – Classification of system- open loop and closed loop systems – Mathematical models: Transfer function model, State model.

Transfer function model: Block diagram representation – Reduction of Block Diagram – Techniques - Signal flow graph representation – Mason's formula – Block diagram to Signal flow graph - Examples and problems – Derivation of transfer function of dc motor.

State Model: Definition of state space & State variables – Modeling of dynamic systems using state variables – Examples.

UNIT – IV

Time and Frequency Response of Linear Systems

Type and order of a system -First order and second order systems – Systems with unity and non – Unity feedback - Impulse response and step response of first and second order linear systems.

Time domain specifications: rise time, delay time, overshoot and settling time of first order and second order systems.

Steady state error and error constants – Generalized error constants - Problems.

Frequency Response

Frequency response specifications: resonant peak, resonant frequency, bandwidth, cut-off rate - correlation between time and frequency response of second order system.

TEXT BOOKS

1. Tarun Kumar Rawat,*Signals and Systems*, Oxford University Press, Fifth Reprint, 2012.
2. Alan V. Oppenheim and Alan S. Willsky with S. Hamid Nawab, *Signals and Systems*, Pearson Education, 2nd Edition, 2008.
3. I.J. Nagrath & M. Gopal, *Control System Engineering,* New Age International, 2001.
4. Katsuhiko Ogata*, Modern Control Engineering,* 3rd Edition, Prentice Hall, India, New Delhi, 2000.
5. S.K.Bhattacharya, *Linear Control System,* 2ndEdition, Pearson education, 2011.

Online Materials

NPTEL – http://www.youtube.com/playlist?list=PL75A2863DF4CE1CE6

NPTEL – http://nptel.ac.in/courses/108102043/

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	-	-	-	3	3	-	2	3	-	2
CO2	3	3	1	1	3	1	-	-	3	3	-	1	2	1	3
CO3	3	3	3	2	3	1	-	-	3	3	-	2	3	2	3
CO4	3	3	3	2	3	-	-	-	3	3	-	2	3	1	3

Course Objectives:

- To enable the learners to design combinational and sequential logic circuits.
- To familiarize the architecture, interfacing of peripheral, I/O devices and assembly language programming of 8086 microprocessor
- To design small scale embedded systems using AVR-based microcontrollers
- To introduce basic knowledge in VLSI design

Course Outcomes:

Upon completion of the course, students will be able to

CO1: Design combinational logic circuits, synchronous & asynchronous sequential circuits.

CO2: Design and analyse finite state machines towards the development of digital systems.

CO3: Interface various peripheral & I/O modules with 8086 microprocessor

CO4: Develop assembly / C code for AVR-based microcontrollers and design small scale embedded systems using VLSI

Syllabus

Unit-I

Boolean Simplification & Logic Family

Review of Number Systems and Codes -Boolean Functions: Boolean Laws- Simplification using the Laws- Minterms- Maxterms- Sum of Product and Product of Sum forms – Simplification of Boolean expressions using Karnaugh Map – Quine McClusky Method -NAND, NOR Implementation.

Digital Logic families: RTL- DTL – ECL – TTL – CMOS Logic Families- Characteristics -Comparison of IC Families.

Unit-II

Combinational & Sequential Circuits

Adders and Subtractors, Multiplexers and Demultiplexers, Encoders and Decoders, Code converters, Magnitude Comparators

Flip flops: RS, D, JK and T, Characteristics equation and excitation table-Master Slave Flip flops-Realization of one flip flop using other flip flops.

Shift registers, Counters, finite state machines, Memories: Memory basics – Types of Memories: RAM, ROM, PROM and Flash Memory – Memory expansion.

Unit-III

Microprocessors and Controllers

Intel 8086 architecture – Registers – Memory segmentation – Pin description – Minimum and maximum mode – Read and write bus cycles – Interrupt processing.

Machine language Vs Assembly language – Assembler – Cross assembler – Assembler directives. Peripheral ICs: 8255 PPI – 8253 PIT – 8259 PIC – 8251 USART.

Introduction to Microcontroller – Comparison of Microcontrollers and Microprocessor – AVR CPU Core – AVR ATmega8 Memories – System Clock and Clock Options –System Control and Reset – Interrupts –A/D Converter

IC Fabrication Technology: CMOS Processing Technology – Fundamentals of Fabrication – Basic CMOS technology – P-well, N-well, Twin-tub and SOI – Gallium Arsenide technology.

Text Books / Reference Books

1. M.Morris Mano, *Digital Design,* 4thEdition, Pearson Education, 2011.
2. T.L.Floyd, *Digital Fundamentals,* 10th Edition, Pearson Education, 2011.
3. Albert Malvino Leach, *Digital principles and Applications,* 5th Edition, Tata Mc-Graw Hill, 2005.
4. Nilesh B Bahadure. Microprocessors and the Pentium Family, PHI, 2010.
5. Barry B. Brey. The Intel Microprocessors, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, PentiumPro Processor, Pentium II, Pentium III, Pentium IV, Architecture, Programming & Interfacing, 8th Edition, Pearson Prentice Hall, 2009.
6. Muhammad Ali Mazidi, SarmadNaimi, SepehrNaimi. *AVR Microcontroller and Embedded Systems: Using Assembly and C*, Pearson Education Inc, 2011
7. Douglas A.Pucknell and Kamran Eshraghian.Basic VLSI Design, 3rd Edition, PHI, 2011.

ONLINE MATERIALS

http://www.youtube.com/playlist?list=PLF322552FBCA61BA7

http://nptel.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/digital_circuit/frame/index.html

https://www.youtube.com/watch?v=liRPtvj7bFU

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	1	3	2	-	-	3	3	-	2	2	3	2
CO2	3	2	1	2	3	2	-	-	3	3	-	-	2	3	2
CO3	3	2	3	2	3	-	3	3	3	3	3	2	2	3	2
CO4	3	2	3	2	3	-	3	3	3	3	3	2	2	3	2

Semester VIII

24AIM449 - Major project **Credits: 13 (Total = 13 + 2 = 15)**