DHANALAKSHMI SRINIVASAN
COLLEGE OF ENGINEERING
(AUTONOMOUS)
COIMBATORE - 641 105 | www.dsce.ac.in

DEPARTMENT OF BIOMEDICAL ENGINEERING

REGULATIONS-2024

B.E. – BIOMEDICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

NH -47, Palakkad Main Road, Post, Navakkarai,
Coimbatore-641 105
Tamil Nadu, India

REGULATIONS – 2024
DEPARTMENT OF BIOMEDICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER–I

S. No.	Course Code	Course Title	Category	L	T	P	Contact Hours	C
THEORY								
1	HS24001	Communicative English – I	HSM	3	0	0	3	3
2	MA24001	Engineering Mathematics – I	BS	3	1	0	4	4
3	PH24001	Engineering Physics	BS	3	0	0	3	3
4	CY24001	Engineering Chemistry	BS	3	0	0	3	3
5	ES24001	Engineering Graphics	ES	2	0	4	6	4
6	TA24001	Heritage of Tamils	HSM	1	0	0	1	1
7	MN24001	Overview of Engineering and Technology	MN	3	0	0	3	0
PRACTICALS								
8	BS24001	Engineering Physics & Chemistry Laboratory	BS	0	0	4	4	2
9	ES24002	Engineering Practices Laboratory	ES	0	0	4	4	2
10	HS24002	Communicative Laboratory	HSM	0	0	2	2	1
TOTAL				**18**	**1**	**14**	**33**	**23**

SEMESTER–II

S. No	Course Code	Course Title	Category	L	T	P	Contact Hours	C
THEORY								
1.	HS24003	Communicative English II	HSM	3	0	0	3	3
2.	MA24002	Statistics and Numerical Methods	BS	3	1	0	4	4
3.	BM24001	Bioscience	ES	3	0	0	3	3
4.	CS24001	Problem Solving and Python Programming	ES	3	1	0	4	4
5.	BM24002	Medical Physics	BS	3	0	0	3	3
6.	TA24002	Tamils and Technology	HSM	1	0	0	1	1

7.	MN24002	Environmental Science and Sustainability	MN	3	0	0	3	0
PRACTICALS								
8.	BM24003	Bioscience Laboratory	PC	0	0	4	4	2
9.	CS24002	Problem Solving and Python Programming Laboratory	ES	0	0	4	4	2
TOTAL				**19**	**2**	**8**	**29**	**22**

SEMESTER– III

S. No	Course Code	Course Title	Category	L	T	P	Contact Hours	C
THEORY								
1.	MA24303	Probability & Statistics	BS	3	1	0	4	4
2.	BM24301	Basics of Electrical, Electronics and Communication Engineering	ES	3	0	0	3	3
3.	BM24302	Introduction to Biomedical Engineering	PC	3	0	0	3	3
4.	BM24321	Human Anatomy & Physiology	PC	3	0	2	5	4
5.	BM24303	Analog and Digital Electronics	ES	3	0	0	3	3
6.	BM24304	Biosensors & Transducers	PC	3	0	0	3	3
7.	BM24305	Soft Skill- Verbal & Reasoning	MN	0	0	0	3	0
PRACTICALS								
8.	BM24311	Analog and Digital Electronics Laboratory	ES	0	0	4	4	2
9.	BM24312	Biosensors & Transducers Laboratory	PC	0	0	4	4	2
TOTAL				**18**	**1**	**10**	**32**	**24**

SEMESTER – IV

S. No	Course Code	Course Title	Category	L	T	P	Contact Hours	C
THEORY								
1.	BM24401	Biomedical Instrumentation	PC	3	0	0	3	3
2.	BM24421	Artificial Intelligence & Machine Learning	PC	3	0	2	5	4
3.	BM24402	Biomedical Signal Processing	PC	3	1	0	4	4
4.	BM24422	Virtual Reality and Augmented Reality in Medical Applications	PC	3	0	2	5	4
5.	BM24403	Biocontrol System	PC	3	0	0	3	3
6.	BM24404	Biomechanics	PC	3	0	0	3	3
7.	BM24405	Testing and Calibration of Medical Equipments	MN	3	0	0	3	0

PRACTICALS								
8.	BM24411	Biomedical Signal Processing Laboratory	PC	0	0	4	4	2
9.	BM24412	Biomedical Instrumentation Laboratory	PC	0	0	4	4	2
TOTAL			**TOTAL**	**21**	**1**	**12**	**34**	**25**

HS24001 COMMUNICATIVE ENGLISH-I								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	3	0	0	45	3	40	60	100

Course Objectives

- To enable learners to understand the basics of communication.
- To empower learners to use narrative techniques to convey ideas and experiences in academic and work environment.
- To support learners in enhancing their linguistic competence and engaging in effortless dialogue.
- To assist learners in mastering language for the successful academic and professional communication.
- To strengthen language proficiency for effective comprehension of core curricula.

UNIT I - Basics of Communication **Listening -** Telephone conversation, Listening to Podcast, NEWS, Interviews **Speaking -** Verbal and Non-Verbal Conversation, Role play **Reading** - Types of Reading- Skimming, Scanning, Intensive and Extensive finding key information in a given text **Writing -** Passage Comprehension , Formal Letter Writing Professional Email Writing **Grammar -** Parts of Speech - Noun, Verb, Pronoun & Adverb, Tense -Present Tense, Types of Sentences **Vocabulary -** Prefix & Suffix	**9**
UNIT II - Narrative Skill Development **Listening -** Watching travel documentary **Speaking -** Narrating a story , Narrating a personal incident **Reading -** Reading Travelogues, Blogs **Writing** Paragraph Writing, Rearrangement of jumbled sentences **Grammar -** Tense Past Tense, Subject Verb Agreement, Auxiliary and Modal Verbs **Vocabulary -** Synonyms and Antonyms	**9**
UNIT III Enriching Speaking Skills **Listening -** Dialogues & conversations **Speaking -** Group Conversation, Speaking on given topics and context **Reading -** Reading Newspaper Articles, Reading user manuals **Writing -** Instructions, Writing definitions **Grammar -** Adjective, Tense Future Tense, Types of Questions WH Questions **Vocabulary -** Abbreviations & Acronyms	**9**
UNIT IV - Language Enhancement **Listening -** Listening to TED Talks **Speaking -** Speaking about friends/places/hobbies, Delivering Welcome Address **Reading -** Reading Biography, Reading Editorial **Writing -** Short Report writing **Grammar** Preposition, Question Tags, Yes or No questions, Articles **Vocabulary** One word Substitution	**9**
UNIT V - Technical Usage of Language **Listening -** Listening to native dialects & live commentaries **Speaking -** Group Discussion, Debates, Proposing Vote of Thanks	**9**

Reading - Opinion articles, Journal Reports **Writing -** Essay Writing **Grammar -** Cause and Effect expressions**,** Negations **Vocabulary -** Gerund & infinitives, Compound Noun	
Total Hours	**45**

Textbook(s)	
1	English for Engineers & Technologists Orient Blackswan Private Ltd., Anna University, 2020.
2	Veena Selvam, Sujatha Priyadarshini, Deepa Mary Francis, K. N. Shoba, Lourdes Joevani, English for Science & Technology, Cambridge University Press, 2021.
Reference(s)	
1	English for Academic Correspondence and Socializing by Adrian Wall work, Springer, 2011.
2	Ashraf Rizvi, "Effective Technical Communication", 2nd Edition, McGraw-Hill India, 2017.
3	Meenakshi Raman, Technical Communication, Oxford University Press, New Delhi, 2017
4	Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai, 2011.

On the successful completion of the course, students will be able to

Course Outcomes		Level
CO1	Communicate effectively using grammatical words according to the context.	K1
CO2	Analyze the given context and frame content accordingly using narrative skills.	K2
CO3	Effectively use language techniques in extended discussions.	K2
CO4	Frame short and long sentences using grammatical techniques according to given context.	K1
CO5	Respond with clarity and accuracy in a range of professional situations, using appropriate linguistic accuracy.	K3

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**1**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**3**	**-**	**3**	**-**	**-**	**-**
CO2	**1**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**3**	**-**	**3**	**-**	**-**	**-**
CO3	**2**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**-**	**-**	**-**
CO4	**2**	**3**	**2**	**3**	**-**	**3**	**3**	**3**	**2**	**3**	**-**	**3**	**-**	**-**	**-**
CO5	**2**	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**-**	**-**	**-**
3 – Strong, 2 – Medium, 1 – Low															

MA24001 – ENGINEERING MATHEMATICS – I								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	3	1	0	60	4	40	60	100

Course Objectives

- Understand the concept of matrices and reduction quadratic form to canonical form.
- Solve the problems using fundamentals principles of calculus.
- Apply the concept of calculus in several variables.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.

UNIT I - MATRICES Eigen values and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.	**12**
UNIT II – DIFFERENTIAL CALCULUS Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications: Maxima and Minima of functions of one variable	**12**
UNIT III - FUNCTIONS OF SEVERAL VARIABLES Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.	**12**
UNIT IV – INTEGRAL CALCULUS Definite and Indefinite integrals - Substitution rule - Techniques of Integration: Integration by parts(reduction),Trigonometric substitutions, Integration of rational functions by partial fraction,improper intergrals.	**12**
UNIT V - MULTIPLE INTEGRALS Double integrals – Change of order of integration – Double integrals in polar coordinates – Area as a double integral - Triple integrals.	**12**
Total Hours	**60**

Textbook(s)

1	Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2	Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2018.
3	James Stewart, "Calculus:Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015.

Reference(s)

1	Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10th Edition, 2016.
2	Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd), New Delhi, 7th Edition, 2009.
3	Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2016.

4	Narayanan. S. and Manicavachagom Pillai. T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6	Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.
7	Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.

On the successful completion of the course, students will be able to

Course Outcomes		Level
CO1	Understand the matrix algebra methods for solving practical problems.	K2
CO2	Apply differential calculus tools in solving various application problems.	K4
CO3	Use differential calculus ideas on several variable functions.	K3
CO4	Apply different methods of integration in solving problems.	K4
CO5	Apply multiple integral ideas to find the area.	K3

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**2**	**3**	**-**	**-**	**-**
CO2	**3**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**2**	**3**	**-**	**-**	**-**
CO3	**3**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**2**	**3**	**-**	**-**	**-**
CO4	**3**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**2**	**3**	**-**	**-**	**-**
CO5	**3**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**2**	**3**	**-**	**-**	**-**
3 – Strong, 2 – Medium, 1 – Low															

PH24001 – ENGINEERING PHYSICS

Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	3	0	0	45	3	40	60	100

Course Objectives

- To introduce the concepts of Laser and its applications.
- To achieve an understanding of mechanics.
- To introduce the concepts of thermal physics.
- To gain knowledge about the basics of quantum mechanics.
- To understand the applications of quantum mechanics.

UNIT I – LASER Theory of laser - characteristics - spontaneous and stimulated emission - Laser action- Einstein's A and B coefficients derivation - pumping methods - resonant cavity, optical amplification (qualitative) - population inversion - Types of laser – Nd -YAG laser, CO_2 laser - Basic applications of lasers in industries – laser heat treatment in annealing, welding, drilling, cutting and soldering – Application of laser in fibre optic communication system.	**9**

UNIT II - MECHANICS Linear motion and rotational motion – Multi particle dynamics – Center of mass (CM) – kinetic energy of system of particles– Physical significance of moment of inertia – M.I of a diatomic molecule – Torsional pendulum.	**9**
UNIT III - THERMAL PHYSICS Modes of heat transfer - thermal conduction, convection and radiation - heat conduction in solids - thermal conductivity - Lee's disc method: theory and experiment - conduction through compound media (series and parallel) - Application: Solar water heater.	**9**
UNIT IV - BASIC QUANTUM MECHANICS Photons and light waves - wave particle duality - De Broglie's wavelength - Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization - particle in an infinite potential well - particle in a 3D box - correspondence principle (qualitative).	**9**
UNIT V - APPLIED QUANTUM MECHANICS Barrier penetration and quantum tunneling (qualitative)- Scanning Tunneling microscope – Resonant diode – Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model.	**9**
Total Hours	**45**

Textbook(s)	
1	M. N. Avadhanulu, P. G. Kshirsagar, T. V. S. Arun Murthy, "A Textbook of Engineering Physics", 11th Edition, S. Chand & Company Pvt. Ltd., New Delhi, 2019.
2	D. K. Bhattacharya, T. Poonam, "Engineering Physics". Oxford University Press, 2015.
3	R. K. Gaur, S. L. Gupta, "Engineering Physics", Dhanpat Rai Publications, 2013.
4	D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017
Reference(s)	
1	R. Wolfson, "Essential University Physics", Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2	D. Halliday, R. Resnick, J. Walker, "Principles of Physics", Wiley Publishers (Indian Edition), 2015.
3	Dattu R Joshi, "Engineering Physics", 1st Edition, Tata McGraw Hill Publications, New Delhi, 2010.
4	B. K. Pandey, S. Chaturvedi, "Engineering Physics", Cengage Learning India, 2017.
5	Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, "Concepts of Modern Physics", McGraw Hill (Indian Edition), 2017.

On the successful completion of the course, students will be able to

Course Outcomes		Level
CO1	Gain knowledge about lasers and its applications.	K2
CO2	Understand the importance of mechanics.	K1
CO3	Acquire knowledge on the concepts of thermal physics.	K2
CO4	Understand the concepts of quantum mechanics.	K1
CO5	Comprehend and express their knowledge about applications of quantum mechanics.	K3

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1	-	-	-	-	-	-	-	-	-
CO2	3	3	2	1	2	1	-	-	-	-	-	-	-	-	-
CO3	3	3	2	2	2	1	-	-	-	-	-	1	-	-	-
CO4	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
CO5	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
3 – Strong, 2 – Medium, 1 – Low															

CY24001 – ENGINEERING CHEMISTRY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	3	0	0	45	3	40	60	100

Course Objectives

- The objective of this course is to better understanding of basic concepts of chemistry and its applications on engineering domine.
- It imparts knowledge on properties of water and its treatment methods, different types of fuels and its applications.
- It also imparts knowledge about different storage devices.
- This course also highlights the preparation, properties and applications of nanomaterials.
- It also gives basic idea about different types of engineering materials.

UNIT I - WATER TECHNOLOGY **Water Technology:** Introduction – Sources − Impurities − Hardness of water −Estimation of harness of water − Boiler feed water − Boiler troubles (Scale and Sludge, Boiler corrosion, Caustic embrittlement, Priming and Foaming)− Treatment of boiler feed water − Internal treatment (Phosphate, Sodium aluminate, Colloidal, Calgon conditioning) − External treatment (Demineralisation process, Zeolite process) − Desalination process − Reverse Osmosis − Municipal water treatment– Case study.	**9**
UNIT II - FUELS **Fuels:** Introduction − Classification of fuels − Solid fuels − Coal and Coke − Metallurgical coke − Manufacture of metallurgical coke (Otto Hoffmann's by-product oven) − Liquid fuels − Petroleum and Diesel − Synthetic petrol (Bergius process) − Knocking in petrol − Octane number − Knocking in diesel − Cetane number − Power alcohol – Gaseous fuels – Natural gaseous fuel – Synthetic gaseous fuel (CNG, LPG) – Flue gas analysis – ORSAT method.	**9**
UNIT III - ELECTROCHEMICAL STORAGE DEVICES **Batteries:** Introduction – Types of batteries – Primary battery (Dry cell) – Secondary battery (Lead acid battery) – Modern battery (Lithium ion battery) – Fuel cells – H_2-O_2 fuel cell– Solar Cells –Electric vehicles: Working principles –Super capacitors: Types and examples.	**9**
UNIT IV - NANO CHEMISTRY **Nano Materials:**Introduction – Types of nano materials – Nanoparticle, Nanocluster, Nanorod, Nanowire and Nanotube – Preparation of nanomaterials (Sol-gel, Solvothermal, Chemical vapour deposition (CVD), Electro chemical deposition (ECD), Laser ablation and	**9**

Electro spinning methods) – Applications of nanomaterials.	
UNIT V - ENGINEERING MATERIALS **Engineering Polymers:** Introduction – Types of polymers (Natural and Synthetic polymers) – Polymerization – Types of polymerization (Addition polymerization and Condensation polymerization) –Degree of polymerization – Thermosetting and Thermoplastic polymers– Application of polymers.	**9**
Total Hours	**45**

Textbook(s)	
1	P. C. Jain and Monica Jain, "A Text Book of Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company Pvt Ltd, New Delhi, 2020.
2	Shashi Chawla "A Text Book of Engineering Chemistry" 3rd Edition, Dhanpat Rai Publishing Company Pvt Ltd, New Delhi, 2011.
3	S. S. Dara and S. S. Umare "A Text Book of Engineering Chemistry", 12th Edition, S. Chand & Company Publishing, 2018.
4	B. Sivasankar, "Engineering Chemistry", Tata McGraw Hill Publishing Company Ltd, New Delhi, 2008.
Reference(s)	
1	Shikha Agarwal, "Engineering Chemistry - Fundamentals and Applications", 2nd Edition, Cambridge University Press, New Delhi, 2019.
2	B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath, James Murday, "Text Book of Nanoscience and Nanotechnology", Universities Press – IIM Series in Metallurgy and Materials Science, 2018.
3	V. R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, "Polymer Science" New Age International Publishers, 2009.

On the successful completion of the course, students will be able to

Course Outcomes		**Level**
CO1	Knowledge about different types of water and propose suitable methods for treatment of water.	K1
CO2	Customize various types of fuels for engineering processes and applications.	K3
CO3	Dramatize different storage devices and apply the concepts in engineering energy sectors.	K3
CO4	Identify and apply the basic concepts of nanotechnology and design the synthesis of nano materials for the applications of engineering and technology.	K1
CO5	Summarize the types of engineering materials and their suitable applications in recent technologies.	K2

Mapping with Program Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**2**	**1**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO2	**2**	**-**	**-**	**1**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**1**	**1**	**-**	**-**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**1**	**2**	**1**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
3 – Strong, 2 – Medium, 1 – Low															

ES24001 – ENGINEERING GRAPHICS								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	2	0	4	60	4	40	60	100

Course Objectives

- Drawing engineering curves and free hand sketch of simple objects.
- Drawing orthographic projection of points, lines and plane surface.
- Drawing orthographic projection of solids.
- Drawing development of solids and section of solids.
- Drawing isometric and perspective projections of simple solids.

CONCETPS AND CONVENTIONS (Not for Examination) Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning. **UNIT I - PLANE CURVES AND FREE HAND SKETCHING** Basic Geometrical constructions, Curves used in engineering practices: Conics - Construction of ellipse, parabola and hyperbola by eccentricity method - Construction of cycloid - construction of involutes of square and circle - Drawing of tangents and normal to the above curves.	**12**
UNIT II - PROJECTION OF POINTS, LINES AND PLANE SURFACE Orthographic projection – principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only first angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of Planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.	**12**
UNIT III - PROJECTION OF SOLIDS Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method and auxiliary plane method.	**12**
UNIT IV - PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other-obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids-Prisms, Pyramids cylinders and cones.	**12**
UNIT V - ISOMETRIC AND PERSPECTIVE PROJECTIONS Principles of isometric projection - isometric scale - Isometric projections of simple solids and truncated solids- Prisms, Pyramids cylinders and cones. Combination of two solid objects vertical positions. Perspective projection of simple solids- Prisms, Pyramids and cylinders by visual ray method. Computer assisted isometric and perspective projections.	**12**

	Total Hours	**60**
Textbook(s)		
1	N. D. Bhatt,V. M. Panchal, "Engineering Drawing", 53rd Edition, Charotar Publishing House, 2019.	
2	K. V. Natrajan,"A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.	
3	N. S. Parthasarathy, Vela Murali, "Engineering Drawing", Oxford University Press, 2015.	
Reference(s)		
1	Basant Agarwal,C. M. Agarwal, "Engineering Drawing", McGraw Hill, 2ndEdition, 2019.	
2	K. R. Gopalakrishna, "Engineering Drawing" (Vol.I & II combined), 27th Edition, Subhas Publications, Bangalore, 2017.	
3	J. Luzzader, Warren,M. Duff, John, "Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.	
4	N. S. Parthasarathy, Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.	
5	M. B. Shah, B. C. Rana, "Engineering Drawing", 2ndEdition, Pearson Education India, 2009.	
6	K. Venugopal,V. Prabhu Raja, "Engineering Graphics", New Age International (P) Ltd, 2008.	

On the successful completion of the course, students will be able to

Course Outcomes		**Level**
CO1	Familiarize with the fundamentals and standards of engineering drawing. Construct the conic curves, in volutes and cycloid, and perform free hand sketching of basic geometrical constructions and multiple views of objects.	K3
CO2	Draw the orthographic projections of points, lines and plane surfaces.	K4
CO3	Draw the projection of simple solids.	K3
CO4	Draw the projection of sectioned solids and draw the development of surfaces of simple solids.	K3
CO5	Visualize and projections of Isometric and perspective projections of simple solids.	K5

Mapping with Program Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**2**	**2**	**2**	**-**
CO2	**3**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**2**	**2**	**2**	**-**
CO3	**3**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**2**	**2**	**2**	**-**
CO4	**3**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**2**	**2**	**2**	**-**
CO5	**3**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**2**	**2**	**2**	**-**
3 – Strong, 2 – Medium, 1 – Low															

TA24001 – HERITAGE OF TAMILS								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	1	0	0	15	1	40	60	100

Course Objectives

- To learn the extensive literature of classical tamil.
- To review the fine arts heritage of tamil culture.

- To realize the contribution in Indian freedom struggle.
- To understand the role of Temple in Sangam cities/ports, Chola conquest.
- To examine Tamil cultural influence in India.

UNIT I - LANGUAGE AND LITERATURE Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil.	**3**
UNIT II - HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari.	**3**
UNIT III - FOLK AND MARTIAL ARTS Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.	**3**
UNIT IV - THINAI CONCEPT OF TAMILS Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age.	**3**
UNIT V - CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement Inscriptions & Manuscripts.	**3**
Total Hours	**15**

Textbook(s)

1	தமிழக வரலாறு - மக்களும் பண்பாடும், கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் – முனைவர். இல சுந்தரம் (விகடன் பிரசுரம்).
3	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு).
4	பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு).

Reference(s)

1	Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL (in print).
2	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies
3	Historical Heritage of the Tamils (Dr. S. V. Subramanian, Dr. K. D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies).
5	Keeladi - 'Sangam City Civilization on the banks of River Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr. K. K. Pillay) (Published

	by: The Author).
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
8	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL).

On the successful completion of the course, students will be able to

Course Outcomes		Level
CO1	Remember the extensive literature of tamil and its classical nature, musical instruments, Folk, Thinai concept, Indian Freedom Struggle & Aham, Puram and Aram Concept.	K1
CO2	Remember the principles in Thirukural, Bakthi Literature Azhwars and Nayanmars, heritage of sculpture, painting ancient people.	K1
CO3	Understand on folk and martial arts of tamil people, Justice in Sangam Literature, Development of Modern literature in Tamil, Making of musical instruments.	K2
CO4	Understand the Ancient Cities and Ports of Sangam Age of Tamils	K2
CO5	Understand the Cultural Influence of Tamils over the other parts of India, contribution of Tamils self-esteem movement.	K1

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	**3**	**3**	-	**3**	-	**3**	-	-	-
CO2	-	-	-	-	-	-	**3**	**3**	-	**3**	-	**3**	-	-	-
CO3	-	-	-	-	-	-	**3**	**3**	-	**3**	-	**3**	-	-	-
CO4	-	-	-	-	-	-	**3**	**3**	-	**3**	-	**3**	-	-	-
CO5	-	-	-	-	-	-	**3**	**3**	-	**3**	-	**3**	-	-	-
3 – Strong, 2 – Medium, 1 – Low															

TA24001 – தமிழர் மரபு								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ES	Total
I	1	0	0	15	1	40	60	100

Course Objectives

- விரிவான இலக்கியம் மற்றும் செம்மொழி தமிழ் கற்க.
- தமிழ் கலாச்சாரத்தின் நுண்கலை பாரம்பரியத்தை மதிப்பாய்வு செய்ய.
- இந்திய சுதந்திரப் போராட்டத்தில் பங்களிப்பை உணர வேண்டும்.
- சங்க நகரங்கள்/துறைமுகங்களில் கோயிலின் பங்கைப் புரிந்து கொள்ள, சோழர்களின் வெற்றி.
- இந்தியாவில் தமிழ் கலாச்சார தாக்கத்தை ஆய்வு செய்ய.

அலகு I - மொழி மற்றும் இலக்கியம் இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை திருக்குறளில் மேலாண்மைக் கருத்துக்கள் தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் -பக்தி இலக்கியம்,	**3**

ஆழ்வார்கள் மற்றும் நாயன்மார்கள் சிற்றிலக்கியங்கள் தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி.	
அலகு II - மரபு பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - நாட்டுப்புறத் தெய்வங்கள் குமரிமுனையில் திருவள்ளுவர் சிலை .	**3**
அலகு III - நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் தெருக்கூத்து கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து. ஒயிலாட்டம் தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.	**3**
அலகு IV - தமிழர்களின் திணைக் கோட்பாடுகள் தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும்.	**3**
அலகு V - இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம், கையெழுத்துப்படிகள்.	**3**
Total Hours	**15**

Textbook(s)	
1	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் - முனைவர் இல சுந்தரம் (விகடன் பிரசுரம்).
3	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு).
4	பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு).
Reference(s)	
1	Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print).
2	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies).
3	Historical Heritage of the Tamils (Dr. S.V. Subramanian, Dr. K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies).
5	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation,

	Tamil Nadu).
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr. K. K. Pillay) (Published by: The Author).
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8	Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL).

On the successful completion of the course, students will be able to

Course Outcomes		Level
CO1	Remember the extensive literature of tamil and its classical nature, musical instruments, Folk, Thinai concept, Indian Freedom Struggle & Aham, Puram and Aram Concept.	K1
CO2	Remember the principles in Thirukural, Bakthi Literature Azhwars and Nayanmars, heritage of sculpture, painting of ancient people.	K1
CO3	Understand on folk and martial arts of tamil people, Justice in Sangam Literature, Development of Modern literature in Tamil, Making of musical instruments.	K2
CO4	Understand the Ancient Cities and Ports of Sangam Age of Tamils	K2
CO5	Understand the Cultural Influence of Tamils over the other parts of India, contribution of Tamils self-esteem movement.	K1

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	**3**	**3**	-	**3**	-	**3**	-	-	-
CO2	-	-	-	-	-	-	**3**	**3**	-	**3**	-	**3**	-	-	-
CO3	-	-	-	-	-	-	**3**	**3**	-	**3**	-	**3**	-	-	-
CO4	-	-	-	-	-	-	**3**	**3**	-	**3**	-	**3**	-	-	-
CO5	-	-	-	-	-	-	**3**	**3**	-	**3**	-	**3**	-	-	-
3 – Strong, 2 – Medium, 1 – Low															

MC24001 – OVERVIEW OF ENGINEERING AND TECHNOLOGY

Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	3	0	0	45	0	40	60	100

Course Objectives

- To outline the basics of the Civil Engineering.
- To learn the fundamentals of Mechanical Engineering.
- To impart knowledge on fundamental concepts and recent trends in the field of Electrical and Control Systems.
- To provide the overview of the Computer Science and Engineering and AI&DS.
- To provide the overview of Food Technology and Bio Medical Engineering.

UNIT I – INTRODUCTION TO ENGINEERING & TECHNOLOGY	**9**

Science, Engineering and Technology(E&T), Approaches for a Scientific process vs an Engineering process; Engineering Product Life Cycle, processes in Engineering Design Methodology with few examples; various branches in Engineering and Technology (Traditional and Recent), Impact of E&T on human life, (pros & cons); Activities performed by an Engineer, Interdisciplinary nature of real world problems; Revised Bloom's Taxonomy Levels (BTL)	
UNIT II – OVERVIEW OF CIVIL, MECHANICAL AND AGRICULTURAL ENGINEERING Introduction - Who is a civil Engineer? -Roles and Responsibilities- Scope and Opportunities- Structures -Geo Technical Engineering - Estimation and Costing- Construction - Project Management - Structural Engineering - Irrigation and Water Supply. Introduction - Who is a Mechanical Engineer? - Roles and Responsibilities - Scope and Opportunities – Manufacturing- Design - Automobile-Power Generation - Industrial Engineering- computer aided design and manufacturing - computer integrated manufacturing. Introduction - Who is an Agricultural Engineer? - Difference between Agricultural & Horticultural Engineering - Types of Agricultural Engineering - Processing or Post Harvest Engineering - Farm Power and Machinery Engineering - Soil and Water Conservation Engineering - Environmental Control Engineering - Forestry - Wood Product Engineering - Food Engineering - Scope and Opportunities.	**9**
UNIT III – OVERVIEW OF ELECTRICAL, ELECTRONICS AND COMMUNICATION ENGINEERING Introduction- Different between Electrical Engineer and Electronics Engineer - Roles and Responsibilities - Scope and Opportunities - Power Generation and Consumption - Reason development - Current area of research - Energy audit - Energy utilization -PLC- Embedded control systems and computer based control system- wired and wireless communication- satellite communication- IoT communication network.	**9**
UNIT IV - OVERVIEWOF COMPUTER SCIENCE AND ENGINEERING, CYBER SECURITY & AI &DS Introduction- Different between Computer Science and Engineering and AI&DS - Job Description-Roles and Responsibilities - Scope and Opportunities.Computer hardware and software - programming languages, operating system - application of software-database management system (DBMS) - Computer networks - Internet and computer security- Web technology - Mobile application - Artificial intelligent (AI) - Machine learning(ML) - Internet of things(IoT) - Black chain - Cyber security -Cloud computing.	**9**
UNIT V –OVERVIEW OF FOOD TECHNOLOGY AND BIO MEDICAL ENGINEERING Introduction - Scope and Importance of Food Technology - Historical development and trends in the field - Sources of food - Chemical composition of food - Microorganisms in food - Food borne illness and safety measures - Unit operations in food Processing - Principles and methods of Food Processing - Case studies on successful food products or processes. Introduction-Role of Biomedical Engineer - Scope of Biomedical Engineer- Key Areas: Bio materials, Biomechanics, Biomedical Instrumentation, Medical Devices, Clinical Engineering, Cell and Tissue Engineering-Career Opportunities: Research and Development- Applications and Future Directions.	**9**
Total Hours	**45**
Textbook(s)	

1	"Overview of Engineering and Technology", Lecture Notes from DSCE, 2024.
2	"Introduction to Engineering Technology and Engineering" by Val D Hawks, A Brent Strong, 1st Edition, Pearson Publisher, 2000.
Reference(s)	
1	N. R. Banapurmath,V. S. Yalliwal, "Basics of Mechanical Engineering",Vikas Publishing House, 2021.
2	G. Shanmugam, M. S. Palanichamy, "Basic Civil and Mechanical Engineering", McGraw Hill Education; 1st Edition, 2018.
3	D. P. Kothari, I.J. Nagrath, "Basic Electrical Engineering", 4th Edition, McGraw Hill Education, 2019.
4	Albert Malvino, David J. Bates," Electronic Principles (SIE)", 7th Education, McGraw Hill 2017.
5	Reema Thareja, "Fundamentals of Computer", Oxford University Press, 2016.

On the successful completion of the course, students will be able to

Course Outcomes		Level
CO1	Identify the major areas and relate their current trends in Civil Engineering.	K1
CO2	Explain the principles behind various mechanical systems and components.	K2
CO3	Identify different Electricals and Control Systems applied in the Engineering field.	K3
CO4	Relate the various Electronics and Communication Systems involved in real life.	K4
CO5	Understand the components of computer hardware, software, and operating systems and their applications in real life.	K2

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**-**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**1**	**-**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
3 – Strong, 2 – Medium, 1 - Low															

BS24001 – ENGINEERING PHYSICS AND CHEMISTRY LABORATORY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	0	0	4	60	2	60	40	100

ENGINEERING PHYSICS LABORATORY

Course Objectives

- To acquaint the students with practical knowledge of physics principles in various fields such as optics, thermal physics and properties of matter for developing basic experimental skills.
- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.

• To determine error in experimental measurements and techniques used to minimize such errors. • To make the student as an active participant in each part of all lab exercises.	
LIST OF EXPERIMENTS (Any 7 Experiments)	
1. Determination of rigidity modulus of a metallic wire using torsional pendulum.	
2. Determination of Young's modulus – Non-uniform bending method.	
3. Determination of Young's modulus – Uniform bending method.	
4. Determination of Young's modulus – Cantilever method.	
5. Determination of wavelength of the laser using grating.	
6. a) Determination of Acceptance angle and Numerical aperture of an optical fiber. b) Determination of width of the groove using laser.	
7. Determination of thickness of a thin film by air-wedge arrangement.	
8. Determination of velocity of sound and compressibility of liquid using Ultrasonic Interferometer.	
9. Determination of velocity of ultrasonic waves using acoustic grating.	
10. Determination of the band gap of a given semiconducting material.	
11. Determination of Planck's constant and work function using Photoelectric effect.	
12. Determination of frequency of the vibrator using Melde's string arrangement.	
Total Hours	**30**

Reference(s)	
1	M. N. Srinivasan, S. Balasubramanian, R. Ranganathan, "Practical Physics", S. Chand & Sons Educational Publications, New Delhi, 2011.
2	P. R Sasikumar, "Practical Physics", PHI Learning Pvt. Ltd., New Delhi, 2011.

On the successful completion of the course, students will be able to

Course Outcomes		**Level**
CO1	Upon completion of the course, the students will be able to apply principles of elasticity, optics and thermal properties for engineering applications.	K1
CO2	Use graphical models to analyze laboratory data.	K2
CO3	Use mathematical models as a medium for quantitative reasoning and describing physical reality.	K2
CO4	Access, process and analyze scientific information.	K3
CO5	Solve problems individually and collaboratively	K3

Mapping with Program Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**3**	**1**	**1**	-	-	-	-	-	-	-	-	-	-
CO2	**3**	**3**	**2**	**1**	**1**	-	-	-	-	-	-	-	-	-	-
CO3	**3**	**2**	**3**	**1**	**1**	-	-	-	-	-	-	-	-	-	-
CO4	**3**	**3**	**2**	**1**	**1**	-	-	-	-	-	-	-	-	-	-
CO5	**3**	**2**	**3**	**1**	**1**	-	-	-	-	-	-	-	-	-	-
3 – Strong, 2 – Medium, 1 – Low															

ENGINEERING CHEMISTRY LABORATORY

Course Objectives

- To make the students to acquire practical skills in basic understanding of water quality parameters such as, hardness, alkalinity, acidity, DO, chloride and copper content.
- To induce the students to familiarize with electro analytical techniques such as, conductometry, potentiometry and pH metry.
- To demonstrate the synthesis of nano particles.
- To develop skills on analysis of coal.

LIST OF EXPERIMENTS: (Any 7 Experiments)	
1. Estimation of acidity of a water sample using the primary standard.	
2. Determination of types and amount of alkalinity in water sample.	
3. Determination of total, temporary & permanent hardness of water by EDTA method.	
4. Determination of DO content of water sample by Winkler's method.	
5. Determination of chloride content of water sample by Argentometric method.	
6. Estimation of copper content of the given solution by Iodometry.	
7. Estimation of TDS of a water sample by gravimetry.	
8. Determination of strength of strong acid using conductivity meter.	
9. Determination of strength of acids in a mixture of acids using conductivity meter.	
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)	
11. Determination of strength of given hydrochloric acid using pH meter.	
12. Estimation of iron content of the given solution using potentiometer.	
13. Estimation of sodium/potassium present in water using flame photometer.	
14. Preparation of nano particles (TiO_2/ZnO/CuO) by Sol-Gel method.	
15. Proximate analysis of Coal	
Total Hours	**30**

Reference(s)

1	J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, "Vogel's Text Book of Quantitative Chemical Analysis", (2009).
2	G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, "Vogel's Text Book of Quantitative Chemical Analysis, 5th Edition, 2009.

On the successful completion of the course, students will be able to

Course Outcomes		**Level**
CO1	Analyze the quality of water samples with respect to their hardness, alkalinity, acidity and DO.	K4
CO2	Determine the amount of metal ions through volumetric and spectroscopic techniques.	K4
CO3	Analyze and determine the composition of coals.	K3
CO4	Learn simple method of synthesis of nano particles.	K1
CO5	Quantitatively analyze the impurities in solution by electro analytical techniques.	K2

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**-**	**1**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
CO2	**3**	**1**	**2**	**-**	**-**	**1**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO3	**3**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**2**	**1**	**2**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**2**	**1**	**2**	**-**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
3 – Strong, 2 – Medium, 1 – Low															

ES24002 – ENGINEERING PRACTICES LABORATORY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	0	0	4	60	2	60	40	100

Course Objectives

- Prepare pipe line plan; laying and connecting various pipe fittings used in common household plumbing work. Making joints in wood materials used in common household wood work.
- Prepare various welding joints in steel plates using arc welding work
- Wiring various electrical joints in common household electrical wire work.
- Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
- Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

CIVIL ENGINEERING PRACTICES:

PLUMBING WORK:

- Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
- Preparing plumbing line sketches.
- Laying pipe connection to the suction side of a pump.
- Laying pipe connection to the delivery side of a pump.
- Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK:

- Sawing
- Planning
- Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

WOOD WORK STUDY:

- Studying joints indoor panels and wooden furniture.
- Studying common industrial trusses using models.

ELECTRICAL ENGINEERING PRACTICES :

- Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
- Staircase wiring

• Fluorescent Lamp wiring with introduction to CFL and LED types. • Energy meter wiring and related calculations/ calibration • Study of Iron Box wiring and assembly • Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac) • Study of emergency lamp wiring/Water heater	
MECHANICAL ENGINEERING PRACTICES :	
WELDING WORK: • Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding. • Practicing gas welding • Making of models.	
BASIC MACHINING WORK: • (simple) Turning. • (simple) Drilling. • (simple) Tapping.	
SHEET METAL WORK: • Making of as square tray.	
FOUNDRY WORK: • Demonstrating basic foundry operations.	
ELECTRONIC ENGINEERING PRACTICES:	
SOLDERING WORK: • Soldering simple electronic circuits and checking continuity	
ELECTRONIC ASSEMBLY AND TESTING WORK: • Assembling and testing electronic components on a small PCB.	
ELECTRONIC EQUIPMENT STUDY: • Study elements of smart phone. • Study of TV parts and working. • Assembly and dismantle of computer/ laptop	
Total Hours	**60**
Reference(s)	
1.	Shoop, Charles Franklin, "Mechanical Engineering Practice: A Laboratory reference text", McGraw-Hill Publisher, 1956.
2.	S Gowri, T Jayapoovan, "Engineering Practices Lab Manual", Vikas Publishing House, 2011.

On the successful completion of the course, students will be able to

Course Outcomes		Level
CO1	Draw pipe line plan; layout and connect various pipe fittings used in common household plumbing work; make joints in wood materials used in common household wood work.	K1
CO2	Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assembles simple mechanical common household equipments; Make a tray out of metal sheet using sheet metal work.	K2
CO3	Wire various electrical joints in common household electrical wire work.	K2
CO4	Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.	K2

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
CO2	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
CO3	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
CO4	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 – Strong, 2 – Medium, 1 – Low															

HS24002 - COMMUNICATIVE LABORATORY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	0	0	2	30	1	60	40	100

Course Objectives

- To enable learners to understand the basics of communication.
- To empower learners to use narrative techniques to convey ideas and experiences in academic and work environment.
- To support learners in enhancing their linguistic competence and engaging in effortless dialogue.
- To assist learners in mastering language for the successful academic and professional communication.
- To strengthen language proficiency for effective comprehension of core curricula.

Basics of Communication **Listening -** Telephone conversation, Listening to Podcast, NEWS, Interviews **Speaking -** Verbal and Non-Verbal Conversation, Role play **Reading** - Types of Reading- Skimming, Scanning, Intensive and Extensive - finding key information in a given text	**6**
Narrative Skill Development **Listening -** Watching travel documentary **Speaking -** Narrating a story -Narrating a personal incident **Reading -** Reading Travelogues, Blogs	**6**
Enriching Speaking Skills **Listening -**Dialogues & Conversations **Speaking -**Group Conversation, Speaking on given topics and context **Reading -** Reading Newspaper Articles, Reading user manuals	**6**
Language Enhancement **Listening -** Listening to TED Talks, **Speaking -** Speaking about friends/places/hobbies, Delivering Welcome Address **Reading -** Reading Biography, Reading Editorial.	**6**
Technical Usage of Language **Listening -** Listening to native dialects & live commentaries **Speaking -** Group Discussion, Debates, Proposing Vote of Thanks	**6**

Reading - Opinion articles, Journal Reports	
Total Hours	**30**

Reference(s)	
1	English for Academic Correspondence and Socializing by Adrian Wall work, Springer, 2011.
2	Ashraf Rizvi, "Effective Technical Communication", 2nd Edition, McGraw-Hill India, 2017.

On the successful completion of the course, students will be able to

Course Outcomes		Level
CO1	Communicate effectively using grammatical words according to the context.	K3
CO2	Analyze the given context and frame content accordingly using narrative skills.	K4
CO3	Effectively use language techniques in extended discussions.	K3
CO4	Frame short and long sentences using grammatical techniques according to given context.	K3
CO5	Respond with clarity and accuracy in a range of professional situations, using appropriate linguistic accuracy.	K4

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**2**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**
CO2	**2**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**
CO3	**2**	**2**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**
3 - Strong, 2 - Medium, 1 – Low															

HS24003– COMMUNICATIVE ENGLISH – II

Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
II	3	0	0	45	3	40	60	100

Course Objective

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations, participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialization.
- Explore the business communication knowledge and understand the importance of presentation.

UNIT I - INTRODUCTION TO TECHNICAL ENGLISH	
Listening - Listening to talks mostly of a scientific/technical nature and completing information-gap exercises Speaking - Asking for and giving directions	**9**

Reading - reading short technical texts from journals- news papers Writing - purpose statements – extended definitions – writing instructions – checklists- recommendations Language Development - subject verb agreement - compound words	
UNIT II - READING AND STUDY SKILLS Listening - Listening to longer technical talks and completing exercises based on them- Speaking – Describing a process Reading – Reading longer technical texts- identifying the various transitions in a text- paragraphing Writing - Interpreting charts, graphs Vocabulary Development-vocabulary used in formal letters/emails and reports Language Development - Impersonal passive voice, numerical adjectives.	**9**
UNIT III - TECHNICAL WRITING AND GRAMMAR Listening - Listening to classroom lectures/ talks on engineering/technology Speaking - Introduction to technical presentations Reading – longer texts both general and technical, practice in speed reading; Writing - Describing a process, use of sequence words Vocabulary Development - sequence words- Misspelled words. Language Development - embedded sentences.	**9**
UNIT IV - PROFESSIONAL WRITING Listening - Listening to documentaries and making notes. Speaking – mechanics of presentations Reading – reading for detailed comprehension Writing - email etiquette - job application – cover letter – Resume preparation (digital and paper based) – analytical essays and issue based essays Vocabulary Development - finding suitable synonyms-paraphrasing Language Development - clauses- if conditionals.	**9**
UNIT V - BUSINESS COMMUNICATION Listening - TED/Ink talks Speaking – participating in a group discussion Reading – reading and understanding technical articles Writing – Writing reports - accident and survey report – Memos – Notices - Circulars - Minutes of a meeting - Vocabulary Development- verbal analogies- reported speech.	**9**
Total Hours	**45**

Textbook(s)	
1	Swan Michael- Practical English Usage- Oxford University Press.
2	.Thomson.A.J and Martinet. A. V - A practical English Grammar- Oxford India.
Reference(s)	
1	Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice. Oxford University Press: New Delhi,2014.
2	Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015.
3	Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
4	Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007.
5	Means, L. Thomas and Elaine Langlois, English & Communication For Colleges. Cengage Learning, USA: 2007.
6	Troyka & Hesse – Handbook for writers- Pearson Publication, 11th edition, 2017.

On the successful completion of the course, students will be able to

Course Outcome		**Level**
CO1	Use proper technical vocabulary and grammar in appropriate contexts.	K1

CO2	Enhance speaking skills to participate confidently in formal / informal conversations and to do effective Presentations/Discussions.	K2
CO3	Critically read and analyze technical texts and articles of a general kind.	K1
CO4	Acquire a working knowledge of writing strategies, formats and templates of professional writing.	K2
CO5	Analyze different way of communication and get familiarized with proper presentation.	K1

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**1**	**1**	**1**	**1**	**2**	**2**	**0**	**0**	**2**	**3**	**3**	**3**	**-**	**-**	**-**
CO2	**0**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**2**	**3**	**3**	**3**	**-**	**-**	**-**
CO3	**1**	**1**	**0**	**1**	**2**	**1**	**1**	**0**	**2**	**3**	**3**	**3**	**-**	**-**	**-**
CO4	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**2**	**3**	**3**	**3**	**-**	**-**	**-**
CO5	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**3**	**-**	**-**	**-**
3 – Strong, 2 – Medium, 1 – Low															

MA24002 – STATISTICS AND NUMERICAL METHODS

Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
II	3	1	0	60	4	40	60	100

Course Objective

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I - NON- PARAMETRIC TESTS Introduction - The Sign test - The Signed - Rank test - Rank - sum tests - The U test - The H test - Tests based on Runs - Test of randomness - The Kolmogorov Tests	**9+3**
UNIT II - DESIGN OF EXPERIMENTS One way and two way classifications - Completely randomized design – Randomized block design – Latin square design.	**9+3**
UNIT III - SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel – Eigen values of a matrix by Power method and Jacobi's method for symmetric matrices.	**9+3**
UNIT IV - INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION	**9+3**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single integrations using Trapezoidal and Simpson's 1/3 rules.	
UNIT V - NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge - Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.	**9+3**
Total Hours	**60**

Textbook(s)	
1	Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2	Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
Reference(s)	
1	Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016
2	Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3	Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007
4	Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5	Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4th Edition, 2012.
6	Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.

On the successful completion of the course, students will be able to

	Course Outcome	**Level**
CO1	Apply the concept of testing of hypothesis for small and large samples in real life problems.	K1
CO2	Apply the basic concepts of classifications of design of experiments in the field of agriculture	K4
CO3	Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.	K2
CO4	Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.	K3
CO5	Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.	K2

Mapping with Program Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**2**	**-**	**2**	**3**	**-**	**-**	**-**
CO2	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**2**	**-**	**2**	**3**	**-**	**-**	**-**
CO3	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**2**	**-**	**2**	**3**	**-**	**-**	**-**

CO4	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**2**	**-**	**2**	**3**	**-**	**-**	**-**
CO5	**3**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**2**	**-**	**2**	**3**	**-**	**-**	**-**
3 – Strong, 2 – Medium, 1 – Low															

BM24001 – BIOSCIENCE								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
II	3	0	0	45	3	40	60	100

Course Objective

The objective of this course is to enable the student to

- Understand about the Cell degeneration and Cell repair.
- Analyze about the blood related disorders.
- Elaborate about the Microscopes and its function.
- Comprehend about different stage of microbial culture.
- Remember about the immunology and techniques to measure the immunity.

UNIT I - CELL DEGENERATION & REPAIR Cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification, cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumors, carcinogenesis, spread of tumors.	**9**
UNIT II - FLUID AND HAEMOTOLOGICAL DISORDERS Edema, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock. Haematological disorders-Bleeding disorders, Leukaemias, Lymphomas.	**9**
UNIT III - MICROSCOPES AND ITS TYPES Light microscope – bright field, dark field, phase contrast, fluorescence, Electron microscope (TEM & SEM). Preparation of samples for electron microscope. Staining methods – simple, gram staining and AFB staining.	**9**
UNIT IV - MICROBIAL CULTURES Morphological features and structural organization of bacteria, growth curve, identification of bacteria, culture media and its types, culture techniques and observation of culture.	**9**
UNIT V - IMMUNOLOGY Natural and artificial immunity, opsonization, phagocytosis, inflammation, Immune deficiency syndrome, antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies. Disease caused by bacteria, fungi, protozoa, virus and helminthes.	**9**
Total Hours	**45**

Textbook(s)

1	Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2005.
2	Prescott, Harley and Klein, "Microbiology", 7th edition, McGraw Hill, 2008.

Reference(s)

1	Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
2	Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 5th

	Edition 2022.
3	Harley and Klein, "Microbiology", 10th edition, McGraw Hill, 2017

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Explain about the Cell degeneration and Cell repair.	K2
CO2	Attain knowledge about the blood related disorders.	K2
CO3	Describe about the types and working of Microscopes.	K3
CO4	Explain about the growth of micro-organisms	K2
CO5	Analyze about the immunity and various methods available in immunological studies.	K3

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	-	-	-	-	1	-	-	-	2	-	-	1
CO2	2	2	1	-	-	-	-	1	-	-	-	2	-	-	1
CO3	2	1	1	-	-	-	-	1	-	-	-	2	-	-	1
CO4	2	2	1	-	-	-	-	1	-	-	-	2	-	-	1
CO5	2	2	1	-	-	-	-	1	-	-	-	2	-	-	1
3 – Strong, 2 – Medium, 1 – Low															

CS 24001 -PROBLEM SOLVING AND PYTHON PROGRAMMING								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	3	1	0	60	4	40	60	100

Course Objectives

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

UNIT I INTRODUCTION TO PROBLEM SOLVING Fundamentals of Computing, Identification of computational problems, Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion).	**12**

UNIT II BASICS OF PYTHON PROGRAMMING Introduction: Features, Installation, Modes of operations (interpreter and interactive mode); variables and data types: int, float, boolean, string, and list; expressions, statements, operators and comments; modules and functions.	**12**
UNIT III CONTROL STATEMENTS & FUNCTIONS Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values,parameters, local and global scope, function composition, recursion.	**12**
UNIT IV SEQUENTIAL DATA TYPES Strings: String slices, String functions and methods, immutability; Lists: list operations, list slices, list methods, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing – list comprehension.	**12**
UNIT V FILES HANDLING AND EXCEPTIONS Files Handling: File types and operations (open, close, read and write), file positions; command line arguments; Exceptions : Introduction to errors and exceptions, handling exceptions, modules, packages.	**12**
Total Hours	**60**

Textbook(s)	
1	Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2	Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.
Reference(s)	
1	Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2	G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021.
4	Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5	Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

On the successful completion of the course, students will be able to

Course Outcomes		**Level**
CO1	Develop algorithmic solutions to simple computational problems.	K3
CO2	Develop and execute simple Python programs.	K3
CO3	Write simple Python programs using conditionals and loops for solving problems.	K2
CO4	Represent compound data using Python lists, tuples, dictionaries etc.	K2
CO5	Read and write data from/to files in Python programs.	K3

Mapping with Program Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**-**

CO2	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**-**	**-**
CO3	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**	**-**	**-**
CO4	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**-**	**-**
CO5	**1**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**2**	**-**	**-**
3 – Strong, 2 – Medium, 1 – Low															

BM24002 – MEDICAL PHYSICS								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
II	3	0	0	45	3	40	60	100

Course Objective

The objective of this course is to enable the student to

- Understand principles and effects of non-ionizing radiation & its medical applications.
- Analyze the Physics and effects of Sounds
- Understand about the Radioactive Decay and Radio Nuclides Production.
- Remember about the interaction of radiation with matter.
- Evaluate about the various detectors and effects of radiations.

UNIT I - NON-IONIZING RADIATION AND ITS MEDICAL APPLICATION Non-ionizing Electromagnetic Radiation: Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Physics of light, Measurement of light and its unit- limits of vision and colour vision an overview, Thermography– Application.	**9**
UNIT II - PHYSICS OF SOUNDS & ITS MEDICAL USES Physics of sound, Normal sound levels –ultrasound fundamentals – Generation of ultrasound (Ultrasound Transducer) - Interaction of Ultrasound with matter; Cavitation, Reflection, Transmission Scanning systems – Artefacts- Ultrasound- Doppler-Double Doppler Shift-Clinical Applications.	**9**
UNIT III - RADIOACTIVE DECAY & PRODUCTION OF RADIONUCLIDES Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology, Decay series, Production of radionuclides – Cyclotron produced Radionuclide- Reactor produced Radio-nuclide-fission and electron Capture reaction, Production of Radionuclides, radionuclide Generator-Technetium generator.	**9**
UNIT IV - RADIATION INTERACTION WITH MATTER Interaction of charged particles with matter – Specific ionization, linear energy Transfer Range, Bremsstrahlung, Annihilation Interaction of Gamma radiations with matter – Photoelectric effect, Compton Scattering, pair Production, Attenuation of Gamma Radiation, Interaction of neuron with matter.	**9**
UNIT V - RADIATION DETECTION & ITS EFFECTS Detectors- Scintillation Detectors- Gas-Filled Detectors - Ionization Chambers-Geiger–Müller Counters -Acute Radiation Effects - The concept of LD 50 – Radiation syndromes- Central nervous system syndrome - Gastro-intestinal syndrome –Bone Marrow syndrome.	**9**
Total Hours	**45**
Textbook(s)	

1	Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine", 4th Edition, Springer, 2013.
2	B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, "Medical Physics and Biomedical Engineering", 2nd Edition, IOP Publishers.2001.
Reference(s)	
1	Steve Webb, The Physics of Medical Imaging, Taylor & Francis, New York, Second Edition, 2012.
2	J.P. Woodcock, "Ultrasonic, Medical Physics Handbook series 1", Adam Hilger, Bristol, 2002
3	HyltonB.Meire and Pat Farrant "Basic Ultrasound" John Wiley & Sons, 1995
4	John R. Cameron and James G. Skofronick,"Medical Physics", John-Wiley & Sons, 3rd Edition2004.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Describe the non-ionizing radiation and its effects.	K1
CO2	Explain about the Physics of Sound and its medical applications	K2
CO3	Explain the fundamentals of radioactivity and production of radioactive isotop	K2
CO4	Summarizes how ionizing radiation interacts with the human body.	K1
CO5	Analyze about the various methods of radiation detection and its effects.	K2

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
CO2	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
CO3	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
CO4	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
CO5	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
3 – Strong, 2 – Medium, 1 – Low															

TA24002 – TAMILS AND TECHNOLOGY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
II	1	0	0	15	1	40	60	100

Course Objective

- Explore the historical development of technology in the Tamil region
- Examine how traditional Tamil practices and knowledge systems have influenced technological advancements

- Promote inclusivity and diversity in the technology sector, encouraging the participation of Tamils in various technological fields
- Provide a global perspective on Tamil contributions to technology and the role of Tamils in the global technology landscape
- Explore the role of the Tamil language in technology, including the development of software, language processing, and digital content in Tamil.

UNIT I - WEAVING AND CERAMIC TECHNOLOGY Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.	**3**
UNIT II - DESIGN AND CONSTRUCTION TECHNOLOGY Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.	**3**
UNIT III - MANUFACTURING TECHNOLOGY Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads - Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.	**3**
UNIT IV - AGRICULTURE AND IRRIGATION TECHNOLOGY Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.	**3**
UNIT V - SCIENTIFIC TAMIL & TAMIL COMPUTING Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.	**3**
Total Hours	**15**

Textbook(s)	
1	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print).
2	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
Reference(s)	
1	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu.
2	Studies in the History of India with special reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
3	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Understand the extensive literature of Tamil and its classical nature.	K1
CO2	Understand the heritage of sculpture, painting and musical instruments of ancient people.	K2

CO3	Review on folk and martial arts of Tamil people.	K2
CO4	Realization of Thinai concepts, trade and victory of chozha dynasty.	K2
CO5	Understand the contribution of Tamils in Indian freedom struggle, self-esteem movement and siddha medicine.	K2

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**2**	-	-	-	-	-	-	-	-	-	-	**1**	-	-	-
CO2	**2**	-	-	-	-	-	-	-	-	-	-	**1**	-	-	-
CO3	**2**	-	-	-	-	-	-	-	-	-	-	**1**	-	-	-
CO4	**2**	-	-	-	-	-	-	-	-	-	-	**1**	-	-	-
CO5	**2**	-	-	-	-	-	-	-	-	-	-	**1**	-	-	-
3 – Strong, 2 – Medium, 1 – Low															

TA24002 – □□□□□□□□ □□□□□□□□□□□□□□□□

Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
II	1	0	0	15	1	40	60	100

Course Objective

- தமிழ் பிராந்தியத்தில் தொழில்நுட்பத்தின் வரலாற்று வளர்ச்சியை ஆராய்ச்சி செய்யுங்கள்.
- பாரம்பரிய தமிழ் நடைமுறைகளும் அறிவு அமைப்புகளும் தொழில்நுட்ப முன்னேற்றங்களை எவ்வாறு பாதித்துள்ளன என்பதை ஆராயுங்கள்
- பல்வேறு தொழில்நுட்பத் துறைகளில் தமிழர்களின் பங்கேற்பை ஊக்குவித்தல், தொழில்நுட்பத் துறையில் உள்ளடக்கம் மற்றும் பன்முகத்தன்மையை ஊக்குவித்தல்.
- தொழில்நுட்பத்திற்கான தமிழ் பங்களிப்புகள் மற்றும் உலகளாவிய தொழில்நுட்ப நிலப்பரப்பில் தமிழர்களின் பங்கு பற்றிய உலகளாவிய கண்ணோட்டத்தை வழங்கவும்.
- மென்பொருளின் வளர்ச்சி, மொழி செயலாக்கம், தமிழில் டிஜிட்டல் உள்ளடக்கம் உள்ளிட்ட தொழில்நுட்பத்தில் தமிழ் மொழியின் பங்கை ஆராயுங்கள்.

அலகு I - நெசவு மற்றும் பானைத் தொழில்நுட்பம்: சங்க காலத்தில் நெசவுத் தொழில் பானைத் தொழில்நுட்பம் கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.	**3**
அலகு II - வடிவமைப்பு மற்றும் சுட்டிடத் தொழில்நுட்பம் சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு. சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் -மாமல்லபுரச் சிற்பங்களும், கோவில்களும் சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோயில்கள் மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள் -	**3**

பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.	
அலகு III - உற்பத்தித் தொழில் நுட்பம் கப்பல் கட்டும் கலை உலோகவியல் - இரும்புத் தொழிற்சாலை இரும்பை உருக்குதல், எஃகு வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் நாணயங்கள் அச்சடித்தல் மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் சங்கு மணிகள் எலும்புத்துண்டுகள் தொல்லியல் சான்றுகள் சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.	**3**
அலகு IV - வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம் அணை, ஏரி குளங்கள், மதகு சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் கால்நடை பராமரிப்பு கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் கடல்சார் அறிவு - மீன்வளம் முத்து மற்றும் முத்துக்குளித்தல் பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார சமூகம்.	**3**
அலகு V - அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: அறிவியல் தமிழின் வளர்ச்சி -கணித்தமிழ் வளர்ச்சி தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.	**3**
Total Hours	**15**

Textbook(s)	
1	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் - முனைவர் இல சுந்தரம். (விகடன் பிரசுரம்).
Reference(s)	
1	Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu.
2	Studies in the History of India with special reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
3	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

On the successful completion of the course, students will be able to

Course Outcome		**Level**
CO1	தமிழின் விரிவான இலக்கியங்களையும் அதன் செம்மொழித் தன்மையையும் புரிந்து கொள்ளுங்கள்.	K1
CO2	பழங்கால மக்களின் சிற்ப ஓவியம் மற்றும் இசைக்கருவிகளின் பாரம்பரியத்தைப் புரிந்து கொள்ளுங்கள்	K2
CO3	தமிழ் மக்களின் நாட்டுப்புற மற்றும் தற்காப்பு கலைகள் பற்றிய ஆய்வு.	K2
CO4	திணை கருத்துக்கள், வர்த்தகம் மற்றும் சோழ வம்சத்தின் வெற்றி.	K2
CO5	இந்திய சுதந்திரப் போராட்டத்திலும், சுயமரியாதை இயக்கத்திலும், சித்த மருத்துவத்திலும் தமிழர்களின் பங்களிப்பைப் புரிந்து கொள்ளுங்கள்	K2

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO5	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3 – Strong, 2 – Medium, 1 – Low															

MN24002 – ENVIRONMENTAL SCIENCE AND SUSTAINABILITY							
Semester	Hours/Week			Total Hours	Credit	Maximum Marks	
	L	T	P		C	CIAT	ESE	Total
II	3	0	0	30	0	100	00	100

Course Objective

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

UNIT I - ENVIRONMENT AND BIODIVERSITY Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow – ecological succession. Biodiversity - Types of biodiversity: genetic, species and ecosystem biodiversity – Values of biodiversity, India as a megadive/rsity nation – hot-spots of biodiversity – Threats to biodiversity - habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and Endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation.	**6**
UNIT II - ENVIRONMENTAL POLLUTION Causes, Effects and Preventive measures of Air pollution, Water pollution, Soil pollution and Noise pollution. Solid, Hazardous and E-Waste management. Environmental protection, Environmental protection acts.	**6**
UNIT III - RENEWABLE SOURCES OF ENERGY Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.	**6**
UNIT IV - SUSTAINABILITY AND MANAGEMENT Development, GDP, Sustainability - concept, needs and challenges - economic, social and aspects of sustainability - from unsustainability to sustainability - millennium development goals, and protocols - Sustainable Development Goals - targets, indicators and intervention areas Climate change - Global, Regional and Local environmental issues and possible solutions - case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry - A case study.	**6**
UNIT V - SUSTAINABILITY PRACTICES Zero waste and R concept, Circular economy, Material Life cycle assessment,	**6**

Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles - carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization - Socio-economical and technological change.	
Total Hours	**30**
Textbook(s)	
1	Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition,New Age International Publishers, 2018.
2	Benny Joseph, "Environmental Science and Engineering", Tata McGraw Hill, New Delhi, 2016.
Reference(s)	
1	R. K. Trivedi, "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol. I and II, Enviro Media. 38. Edition, 2010.
2	Cunningham, W.P. Cooper, T.H. Gorhani, "Environmental Encyclopedia", Jaico Publ., House, Mumbai, 2001.
3	Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt. Ltd, New Delhi, 2007.
4	Rajagopalan, R, "Environmental Studies - From Crisis to Cure", Oxford University Press, 3rd Edition, 2015.
5	Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.	K1
CO2	To identify the causes, effects of environmental pollution and natural disasters and contributeto the preventive measures in the society.	K1
CO3	To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.	K3
CO4	To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.	K2
CO5	To demonstrate the knowledge of sustainability practices and identify green materials, energycycles and the role of sustainable urbanization	K3

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**2**	**1**	**-**	**-**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
CO2	**3**	**2**	**-**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
CO3	**3**	**-**	**1**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
CO4	**3**	**2**	**1**	**1**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
CO5	**3**	**2**	**1**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
3 – Strong, 2 – Medium, 1 – Low															

BM24003– BIOSCIENCE LABORATORY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
II	0	0	4		2	60	40	100

Course Objective

To provide practice on:

- Know about the parts of microscope.
- Understand the Histopathological and Haematological slides.
- Learn about the Bone marrow charts.
- Gain knowledge about the immunity measurement.

LIST OF EXPERIMENTS:

1. Study of parts of compound microscope
2. Slides of malarial parasites, micro filaria and leishmaniadonovani.
3. Bleeding and Clotting time
4. Antigen-Antibody reaction Immuno electrophoresis
5. Study of Histopathological slides of benign and malignant tumours.
6. Study of Haematology slides of anemia and leukemia.
7. Study of Bone marrow charts
8. Measurement of antibodies- ELISA Reader.
9. Study of microbial culture.
10. Study about the Centrifugation.
11. Staining- Simple and Gram staining Methods.

Total Hours **60**

Reference(s)

1 Textbook of Medical Laboratory Technology, Ramnik Sood, 6thEdition, Jaypee Brothers Medical Publishers, 2009.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Upon completion of the course, students will be able to: Understand the parts and working of compound microscope.	K1
CO2	Study of Histopathological and hematological based slides.	K2
CO3	Measurement of antibodies count.	K2
CO4	Know about the Bone marrow Syndrome using Bone marrow chart.	K3
CO5	Study about the different stages in microbial culture.	K2

Mapping with Program Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	-	-	-	2	2	-	-	2	-	2
CO2	3	2	-	-	-	2	2	-	2	2	-	-	2	-	2
CO3	3	2	-	2	2	2	-	-	2	2	-	-	2	-	2
CO4	3	2	-	-	2	2	-	-	2	2	-	-	2	-	2
CO5	3	2	2	1	2	1	-	-	2	2	-	-	2	-	2
3 – Strong, 2 – Medium, 1 – Low															

CS24002 – PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
I	0	0	4	60	2	60	40	100

Course Objectives

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

LIST OF EXPERIMENTS:

1. a. Write a program for checking the given number is even or odd.
   b. Write a program for displaying reversal of a number.
2. a. Write a program for finding biggest number among 3 numbers.
   b. Write a program using a while loop that asks the user for a number, and prints a countdown from that number to zero.
3. a. Implement python script to check the given year is leap year or not.
   b. Implement Python Script to generate first N natural numbers.
4. a. Implement Python Script to generate first N natural numbers.
   b. Implement Python Script to check given number is palindrome or not.
5. a. Implement Python script to print factorial of a number.
   b. Implement Python Script to print sum of N natural numbers.
6. a. Implement Python Script to check given number is Armstrong or not.
   b. Implement Python Script to generate prime numbers series up to n
7. Finding the minimum and maximum elements in the lists
8. Define a function max_of_three() that takes three numbers as arguments and returns the largest of them.
9. Implement a python script for factorial of number by using recursion
10. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
11. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)

12. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)	
Total Hours	**60**

Reference(s)	
1	Paul Deitel, Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", 3rd Edition, MIT Press, 2021.

On the successful completion of the course, students will be able to

Course Outcomes		**Level**
CO1	Develop algorithmic solutions to simple computational problems.	K2
CO2	Develop and execute simple Python programs.	K2
CO3	Write simple Python programs using conditionals and loops for solving problems.	K3
CO4	Decompose a Python program into functions.	K3
CO5	Represent compound data using Python lists, tuples, dictionaries etc.	K3

Mapping with Program Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**3**	**-**
CO2	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**3**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**	**-**	**-**
CO4	**2**	**2**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**-**	**-**
CO5	**1**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**2**	**-**	**-**
3 – Strong, 2 – Medium, 1 - Low															

III SEM SYLLABUS

MA24303- PROBABILITY & STATISTICS

Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
III	3	1	0	4	4	40	60	100

Course Objective

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two-dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

UNIT I PROBABILITY AND RANDOM VARIABLES Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Exponential and Normal distributions .	**12**
UNIT II TWO - DIMENSIONAL RANDOM VARIABLES Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).	**12**
UNIT III TESTING OF HYPOTHESIS Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-squares and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.	**12**
UNIT IV ESTIMATION THEORY Unbiased estimators - Efficiency - Consistency - Sufficiency - Robustness - Method of moments - Method of maximum Likelihood - Interval estimation of Means - Differences between means, variations and ratio of two variances.	**12**
UNIT V STATISTICAL QUALITY CONTROL Control charts for measurements (X and R charts)-Control charts for attributes (p, c and np charts)-Tolerance limits - Acceptance sampling.	**12**
Total Hours	**60**

Textbook(s)

1	Johnson, R.A., Miller, I and Freund J, Miller and Freund 's Probability and Statistics for Engineers, Pearson Education, Asia, 9th Edition, 2020.
2	Milton. J. S. and Arnold. J.C., Introduction to Probability and Statistics, Tata McGraw Hill, 4th Edition, 2017.
3	John E. Freund, "Mathematical Statistics", Prentice Hall, 5th Edition, 1992.

Reference(s)	
1	Gupta. S.C. and Kapoor. V. K., “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
2	Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2014.
3	Ross. S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5thEdition, Elsevier, 2014.
4	Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum’s Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.
5	Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2010.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.	K1
CO2	Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.	K2
CO3	Apply the concept of testing of hypothesis for small and large samples in real life problems.	K3
CO4	Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.	K4
CO5	Have the notion of sampling distributions and statistical techniques used in engineering and management problems.	K2

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**
CO3	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**
CO4	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**
CO5	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**
3 – Strong, 2 – Medium, 1 – Low														

BM24301- BASICS OF ELECTRICAL, ELECTRONICS AND COMMUNICATION ENGINEERING								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
III	3	0	0	3	3	40	60	100

Course Objective

- To understand the basic concepts of electric circuits and wiring practices.
- To study about the motor and generator principle and working
- To study the working principle of induction motor and alternator.
- To understand the fundamentals of digital logic circuits.
- To understand the basic concepts of communication systems.

UNIT I BASIC ELECTRIC CIRCUITS AND DOMESTIC WIRING Electrical circuit elements (R, L and C)-Dependent and independent sources - Ohm's Law, Kirchhoff's laws - Single phase AC circuits: Phasor- RMS and Average values-sinusoidal steady state response of simple RLC circuits - Types of wiring- Domestic wiring - Electrical Safety - Protective devices and Earthing.	**09**
UNIT II DC MACHINES Introduction - Construction of DC Machine - DC Generator - Working Principle, EMF Equation, Types, Characteristics. DC Motor - Working Principle, Torque Equation, Types, Characteristics, Speed Control.	**09**
UNIT III AC MACHINES Three Phase Induction Motor - Working Principle - Equivalent Circuit, Single Phase Induction Motor - Types-Working Principle, Alternator - Working Principle - Equation of induced EMF- Synchronous motors -Working Principle - Starting methods.	**09**
UNIT IV DIGITAL GATES Number Systems - Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes - Binary, BCD, 84-2-1, 2421, Excess 3, Biquinary, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms.	**09**
UNIT V FUNDAMENTAL OF COMMUNICATION ENGINEERING Introduction - Elements of communication systems - Modulation and Demodulation: principle of amplitude and frequency modulation. Digital communication - Nyquist Sampling Theorem, Pulse Code Modulation, Delta Modulation, BPSK, QPSK (Qualitative Approach)- Communication systems: Radio Antenna, TV, satellite and optical fiber	**09**
Total Hours	**45**

Textbook(s)

1	Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, 4th Edition,2019.
2	Del Toro, "Electrical Engineering Fundamentals", Second edition, Pearson Education, New Delhi, 2015.
3.	M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson, 2014.

Reference(s)

1	Taub & Schilling "Principles of Communication Systems" Tata McGraw Hill 4th edition 2019.
2	Anandkumar," Fundamentals of Digital Circuits",2nd Edition PHI learning 2013.
3	Thomas L. Floyd, 'Digital Fundamentals', 11th Edition, Pearson Education, 2017
4	S.K. Bhattacharya "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition, 2017.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Compute the electric circuit parameters for simple problems and wiring practices.	K2
CO2	Differentiate the working principle of different motors and generators.	K1
CO3	Articulate the working principle of induction motor and alternator.	K2
CO4	Identify the various digital logic gates.	K2
CO5	Enumerate the basic concepts of communication systems.	K1

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
CO2	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
CO3	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
CO4	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
CO5	**3**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
3 – Strong, 2 – Medium, 1 – Low														

BM24302- INTRODUCTION TO BIOMEDICAL ENGINEERING								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
III	3	0	0	3	3	40	60	100

Course Objective

- To acquaint the ethical issues in biomedical engineering.
- To provide basic ideas about the Bioelectric signals & Biomagnetic signals.
- To know about the biomechanics involved in operation of the human system and biomaterials with its properties.
- To know about the working of various medical imaging modalities.
- To comprehend knowledge about AI in biomedical engineering.

UNIT I SOCIAL AND ETHICAL ISSUES RELATED TO BIOMEDICAL ENGINEERING Role of Biomedical Engineers in Healthcare-Importance Biomedical Engineering in Healthcare-Biomedical Engineering Ethics-Principles of clinical research, randomized controlled trials, Technology and community, Environmental aspects of technology related to healthcare delivery, Healthcare economics and health rationing.	**09**
UNIT II PHYSIOLOGICAL SIGNALS Signal representation, Signal in time and Frequency domain, Signal Estimation, Bioelectric Signals: ECG & EEG, Vital Signs, Biomagnetic Signals.	**09**
UNIT III BIOMECHANICS & BIOMATERIALS Mechanical Properties of Tissue - Stress, Strain, Viscosity and Viscoelasticity, Applications of Sports Biomechanics, Biomaterials - Types, Properties, Applications - Artificial heart & Membrane Oxygenators.	**09**

UNIT IV MEDICAL IMAGING SYSTEMS Principles and Applications - X-ray & CT, Ultrasound Imaging, MRI, Nuclear Medicine, Microscopy, Bio photonics.	**09**
UNIT V AI IN BIOMEDICAL ENGINEERING Definition & Scope of AI in Biomedical Engineering-Evolution of AI in Healthcare & Biomedical Engineering-Key AI Technologies-Applications of AI in Biomedical Engineering- Future Trends & Innovations in AI for Biomedical Engineering.	**09**
Total Hours	**45**

Textbook(s)	
1	R. S. Khandpur Biomedical Instrumentation: Technology and Applications TATA Mc Graw Hill 2014.
2	Leslie Cromwell Biomedical Instrumentation and Measurement Prentice Hall of India 2015.
3.	Joseph D. Branzino, "The Biomedical Engineering Handbook", CRC Press, 2000.
Reference(s)	
1	John D. Enderle and Susan M. Blanchard Introduction to Biomedical Engineering Elsevier International Projects Ltd 2005.
2	Laurence J. Street Introduction to Biomedical Engineering Technology CRC Press,4th edition 2023.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Interpret about importance and ethical issues in biomedical engineering.	K1
CO2	Understand the basics of bioelectric signals & biomagnetic signals.	K2
CO3	Identify the correct material for designing implants and mechanics of human body system.	K2
CO4	Describe the imaging systems used in biomedical engineering.	K2
CO5	Interpret knowledge about the AI in biomedical engineering.	K2

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**-**
CO2	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**-**
CO3	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**-**
CO4	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**-**
CO5	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**-**
3 – Strong, 2 – Medium, 1 - Low														

BM24321- HUMAN ANATOMY & PHYSIOLOGY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
III	3	0	2	5	4	50	50	100

Course Objective

- To understand the basic elements of human body with its functions.
- To impart foundational knowledge of the skeletal system, including bone types, joint structures, and cartilage functions.
- To provide a comprehensive understanding of the cardiovascular system, including heart anatomy, conduction pathways, blood composition, and hemodynamics.
- To educate students about the anatomy and physiological functions of the digestive system, including secretion, digestion, and nutrient absorption.
- To enable students to understand the structural and functional organization of the nervous system, including nerve conduction, synaptic transmission, reflex mechanisms, and the autonomic system.

UNIT I BASIC ELEMENTS OF HUMAN BODY Cell - Cell Structure and organelles - Functions of each component in the cell. Cell membrane - transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, functions- Glands-Exocrine and Endocrine	**09**
UNIT II SKELETAL AND MUSCULAR SYSTEM Skeletal: Types of Bone and function - Physiology of Bone formation - Division of Skeleton -Types of joints and function - Types of cartilage and function. -Types of muscles - Structure and Properties of Skeletal Muscle- Changes during muscle contraction- Neuromuscular junction.	**09**
UNIT III CARDIOVASCULAR AND RESPIRATORY SYSTEM Cardiovascular System: Structure - Conduction System of heart - Cardiac Cycle - Cardiac output. Blood: Composition - Functions - Haemostasis - Blood groups and typing. Blood Vessels - Structure and types - Blood pressure - Respiratory system: Parts of respiratory system - Respiratory physiology - Lung volumes and capacities - Gaseous exchange.	**09**
UNIT IV DIGESTIVE AND EXCRETORY SYSTEMS Structure and functions of gastrointestinal system - secretory functions of the alimentary tract - digestion and absorption in the gastrointestinal tract - structure of nephron - mechanism of urine formation - skin and sweat gland - temperature regulation.	**09**
UNIT V NERVOUS AND SENSORY SYSTEM Structure and function of nervous tissue - Brain and spinal cord - Functions of CNS - Nerve conduction and synapse - Reflex action - Somatic and Autonomic Nervous system. Physiology of Vision, Hearing, Integumentary, Olfactory systems. Taste buds.	**09**
Theory	**45**
PRACTICAL EXERCISES	

1. Collection of Blood Samples 2. Identification of Blood groups (Forward and Reverse) 3. Total RBC and WBC Count 4. Differential count of Blood cells 5. Estimation of ESR, PCV, MCH, MCV, MCHC 6. Hearing test - Tuning fork 7. Visual Activity - Snellen's Chart and Jaeger's Chart 8. Study of Various Organs- Heart, Brain, Eye and Ear.	
Practical	**30**
Total Hours	**75**

Textbook(s)	
1	Elaine.N. Marieb, "Essential of Human Anatomy and Physiology", 13th Edition, Pearson Education, New Delhi, 2021.
2	Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine", 4th edition Springer, 2013. (Unit 2,3,4)
Reference(s)	
1	Guyton & Hall, "Text book of Medical Physiology", 13th Edition, Saunders, 2020.
2	Ranganathan T S, "Text book of Human Anatomy", S. Chand& Co. Ltd., New Delhi, 2012.
3	Sarada Subramanyam, K Madhavan Kutty, Singh H D, "Textbook of Human Physiology", S. Chand and Company Ltd, New Delhi, 2010.

On the successful completion of the course, students will be able to

Course Outcome		**Level**
CO1	Identify about the basic elements of human body	K1
CO2	Explain the functions of skeletal and muscular system	K2
CO3	Demonstrate the structure, function of cardiovascular system and respiratory system	K3
CO4	Interpret the mechanism of digestive and excretory system.	K2
CO5	Correlate the physiological process of Nervous and sensory system	K4

Mapping with Program Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
CO2	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
CO3	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
CO4	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
CO5	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**
3 – Strong, 2 – Medium, 1 - Low														

BM24303- ANALOG AND DIGITAL ELECTRONICS								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
III	3	0	0	3	3	40	60	100

Course Objective

- To Study about the diode and its applications.
- To understand about the operation and characteristics of various transistors and amplifiers.
- To gain knowledge about the working of various power supplies and oscillators.
- To comprehend about the various applications of combinational circuits using digital gates.
- To bring out the analysis and design procedures for synchronous and asynchronous sequential circuits.

UNIT I DIODES AND APPLICATIONS Junction diode characteristics: Open circuited p-n junction, p-n junction as a rectifier, V-I characteristics, effect of temperature, diode resistance, diffusion capacitance, diode switching times, breakdown diodes, Tunnel diodes, photo diode, LED. Diode Applications - clipping circuits, comparators, Half wave rectifier, Full wave rectifier, rectifier with capacitor filter.	**09**
UNIT II TRANSISTORS AND AMPLIFIERS Operation and Characteristics - BJT, JFET, MOSFET and IGBT - Amplifiers- CE, CB, Power Amplifiers- Class A, Class B, Class AB- Class C.	**09**
UNIT III POWER SUPPLIES AND OSCILLATORS Fixed and Variable power supply, Linear and Switched Mode Power Supply, Regulated Power Supply, Online and Offline Uninterrupted Power Supply- Oscillators- Condition for Oscillators- RC Oscillators- Phase Shift, LC Oscillators- Hartley Oscillators.	**09**
UNIT IV COMBINATIONAL LOGIC CIRCUITS Basic Theorems and Properties of Boolean Algebra, Canonical and Standard Forms, Digital Logic Gates, The Map Method, Product-of-Sums Simplification, Don't-Care Conditions, NAND and NOR Implementation, Exclusive-OR Function, Binary Adder-Subtractor, Decimal Adder, Binary Multiplier, Magnitude Comparator, Decoders, Encoders, Multiplexers.	**09**
UNIT V SEQUENTIAL LOGIC CIRCUITS Flip flops - SR, JK, T, D, Master/Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits - state minimization, state assignment, circuit implementation. Counters, Ripple Counters, Ring Counters. Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In -Serial Out, Parallel In - Parallel Out, Universal Shift Register.	**09**
Total Hours	**45**

Textbook(s)

1	Sergio Franco, "Design with operational amplifiers and analog integrated circuits", Mc Graw Hill Education, 3rd Edition, 2017
2	John.F. Wakerly, "Digital design principles and practices", Pearson Education, 5th Edition, 2018

Reference(s)

1	Taub and Schilling, "Digital Integrated Electronics", Mc Graw Hill, 2017.
2	S Saliva Hanan and V S Kanchana Bhaaskaran, Linear Integrated Circuits, McGraw Hill Education, 3rd Edition, 2018
3	Charles H. Roth, Jr, "Fundamentals of Logic Design", Jaico Books, 7th Edition, 2013.
4	M. Morris Mano and Michael D. Ciletti, "Digital Design", Pearson, 5th Edition, 2013.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Analyze the V-I characteristics of diodes and its applications.	K1
CO2	Differentiate the V-I characteristics various transistor and applications.	K2
CO3	Acquire knowledge about the working of various power supplies and oscillators.	K3
CO4	Design of various combinational circuits using digital logic gates.	K4
CO5	Design and implement synchronous and asynchronous sequential circuits.	K4

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO2	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO3	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO4	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
CO5	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
3 – Strong, 2 – Medium, 1 - Low														

BM24304- BIOSENSORS & TRANSDUCERS								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIA	ESE	Total
III	3	0	0	3	3	40	60	100

Course Objective

- To define the basic concepts and characteristics of transducers and sensors
- To understand about the basic measurement techniques.
- To discuss the working of thermal based measurements.
- To understand about the various sensor's fabrication process.
- To interpret the concepts of AI usage in biosensors & bio transducers.

UNIT I INTRODUCTION TO TRANSDUCERS AND ITS CHARACTERISTICS Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids Introduction: Generalized Instrumentation System, General Properties of Input Transducer Static Characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift, Hysteresis, Linearity, Input Impedance and Output Impedance. Dynamic Characteristics: First Order and Second Order Characteristics, Time Delay, Error Free Instrument, Transfer Functions. Design Criteria, Generalized Instrument Specifications.	**09**
UNIT II MEASUREMENTS Displacement, motion and Pressure Measurement: (with applications) Resistive: Potentiometers, Strain Gauges and Bridge Circuits. Inductive: Variable Inductance and LVDT Capacitive type, Piezoelectric Transducers. Types of Diaphragms, Bellows, Bourdon Tubes.	**09**
UNIT III THERMAL MEASUREMENTS Temperature Measurement: Thermistor, Thermocouple, Resistive Temperature Detector, IC based Temperature Measurement, Radiation Sensors and Applications.	**09**
UNIT IV BIOSENSORS Chemical Sensors: Blood gas and Acid- Base Physiology Potentiometric Sensors, Ion Selective Electrodes, ISFETS. Ampero metric Sensors, Clark Electrode with examples - pH, pO2, pCO2 Electrodes, Transcutaneous Arterial Oxygen Tension, Carbon Dioxide measurements: capnostat. Biosensor: Classifications: Biological phenomenon, Transduction Phenomenon i.e. Enzyme Sensor and Electrode based: Affinity Sensors (Catalytic Biosensors), Two examples of each Biosensors and Immunosensors	**09**
UNIT V AI IN BIOSENSORS & TRANSDUCERS Role of AI in Enhancing Biosensor Performance- Benefits of AI in Biosensors - Integration of AI with Biosensors and Transducers -Key Components of AI-powered Biosensors- Applications of AI in Biosensors- AI in Lab-on-a-Chip (LoC) Technology- AI in Medical Transducers.	**09**
Total Hours	**45**

Textbook(s)	
1	R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill,3rd edition, 2014.
2	Hermann K P. Neubert Instrument Transducer- An Intro to their performance and design Hermann K P. Neubert, 2nd edition 2003.
3	Harry N, Norton. Biomedical sensors - fundamentals and application Harry N, Norton. 2001
4	NandiniK Electronics in Medicine and Biomedical Instrumentation Jog PHI Second Edition 2013
Reference(s)	
1	LaGeddesand L.E. Baker er Principles of applied Biomedical Instrumentation LaGeddesand L.E. Baker 1997
2	Leslie Cromwell, Fred. Weibel and Pfeiffer Biomedical instrumentation and measurement Leslie Cromwell, Fred.J. Weibel and Pfeiffer 2002
3	Jacob Fraden Handbook of Modern Sensors - Physics, Design and Application AIP press 2000

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Compare the general properties and characteristics of transducers and sensors.	K2

CO2	Differentiate various types of measurements and transducers.	K4
CO3	Apply different thermal based sensors in the measurement and control of temperature in biomedical applications.	K3
CO4	Classify the different types of biosensors used in medical applications.	K2
CO5	Interpret about the AI in sensors and transducers in medical applications.	K1

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**	**-**
CO2	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**	**-**
CO3	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**	**-**
CO4	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**	**-**
CO5	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**	**-**
3 – Strong, 2 – Medium, 1 - Low														

BM24305- SOFT SKILL- VERBAL & REASONING								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
III	3	0	0	3	0	-	-	-

Course Objective

- To help the students understand interpersonal skills.
- To support them in building interpersonal skills.
- To better the ability to work with others.
- To expose students to right attitudinal and behavioral aspects
- To build the right attitudinal through activities

UNIT I COMMUNICATION SKILLS Overview to communication, self-Introduction, Presentation on their own topic, Extempore, Group Activity (Verbal Reasoning - Proposition)	**09**
UNIT II GROUP DISCUSSION Group Discussion, Do's and Don'ts of Group Discussion, Body language, Grooming and Resume, Resume correction, Activity (Verbal Reasoning - Premise)	**09**
UNIT III INTERVIEW SKILLS Introduction to HRM - Questions - Do's and Don'ts - Interview - Mock GD - Stress Management, Activity (Verbal Reasoning - Syllogism)	**09**
UNIT IV PERSONALITY DEVELOPMENT Personality Development - Presentation skills, Interpersonal skills, Critical thinking, Confidence building and Stress management, Activity (Verbal Reasoning - Verbal Analogies)	**09**
UNIT V VERBAL REASONING Vocabulary basics, Grammar basics, Critical Reasoning, Reading comprehension, Logical Reasoning, Analytical puzzles	**09**
Total Hours	**45**

Textbook(s)

1	Barun K Mitra Personality Development and Soft Skills Oxford University Press-New Delhi 2012
2	Rajiv K Mishra Personality Development Rupa & Co 2012.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Communicate smartly and effectively with co-workers, relationship enhancement.	K2
CO2	Determine the time management and organizational skill.	K3
CO3	Acquire the knowledge about the interview skills.	K3
CO4	Demonstrate the skills to develop the Personality, Critical thinking	K3
CO5	Elaborate the concepts of Critical reasoning and Logical reasoning	K2

BM24311 -ANALOG AND DIGITAL ELECTRONICS LABORATORY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIA	ESE	Total
III	0	0	4	4	2	60	40	100

Course Objective

- To Understand about the operations of logic gates.
- To design of combinational logic circuits using various logic gates.
- To design the code conversion circuits.
- To design of various flip- flop using universal logic gates.
- To understand about the counter circuits.

1. Realization of different gates like AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR and Realization of basic gates using universal logic gates.	
2. Gray Code to Binary Code Conversion and Vice Versa.	
3. Construction of simple arithmetic circuits-Adder, Subtractor.	
4. Construction of simple Decoder and Multiplexer circuits using logic gates.	
5. Construction of Four-bit parity generator and comparator circuits.	
6. Realization of R-S, J-K and D flip-flops using Universal logic gates.	
7. Realization of Counter Circuits	
8. Characteristics of PN junction, Zener Diode	
9. Half Wave, Full Wave Rectifier with and without filter.	
10. Input and Output characteristics of Transistor CE, CB configuration.	
Total Hours	**60**

Reference(s)

1	Charles H. Roth. "Fundamentals of Logic Design", 6th Edition, Thomson Learning, 2013.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Acquire knowledge about the working of various logic gates.	K3
CO2	Design various combinational digital circuits using logic gates.	K6
CO3	Develop the code conversion circuits	K6
CO4	Design of various flip-flop using universal logic gates.	K6
CO5	Characterize the working of Transistor in various configuration	K3

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**2**	**-**	**2**	**2**	**2**	**-**	**-**
CO2	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**2**	**-**	**2**	**2**	**2**	**-**	**-**
CO3	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**2**	**-**	**2**	**2**	**2**	**-**	**-**
CO4	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**2**	**-**	**2**	**2**	**2**	**-**	**-**
CO5	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**2**	**-**	**2**	**2**	**2**	**-**	**-**
3 – Strong, 2 – Medium, 1 - Low														

BM24312 - BIOSENSORS & TRANSDUCERS LABORATORY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
III	0	0	4	4	2	60	40	100

Course Objective

- To learn about data acquisition of physiological signal
- To learn about various biosensors
- To distinguish contact and non-contact method of skin temperature measurement
- To outline the working principle of Transducers
- To experiment with basic functions of Biosensors

1. Study of Biological Sensors	
2. Displacement measurement using LVDT	
3. Characteristics of temperature sensors - thermistor and RTD.	
4. Characteristics of thermocouple	
5. Measurement of Unknown Resistance using Kelvin Double Bridge and Wheatstone Bridge.	
6. Characteristics of photo diodes, phototransistor	
7. Characteristics of Piezoelectric Transducer.	
8. Data acquisition of physiological signals	
9. Measurement of skin temperature by both contact and non-contact method.	
10. Measurement of Unknown Capacitance using Schering Bridge.	
11. Measurement of Unknown Inductance using Maxwell's and Hay's Bridge.	
Total Hours	**60**

Reference(s)

1	Hermann K P. Neubert Instrument Transducer- An Intro to their performance and design Hermann K P. Neubert 2000.
2	Harry N, Norton. Biomedical sensors - fundamentals and application Harry N, Norton. 2001

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Interpret the characteristics of various biosensors.	K2
CO2	Design and develop bridge circuits to find unknown variables	K6
CO3	Compute data acquisition of physiological signals	K2
CO4	Differentiate the various characteristics of transducers	K4
CO5	Analyze the different temperature sensors in practical applications.	K3

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	-	-	2	-	2	2	2	-	-
CO2	3	3	2	1	1	-	-	2	-	2	2	2	-	-
CO3	3	3	2	1	1	-	-	2	-	2	2	2	-	-
CO4	3	3	2	1	1	-	-	2	-	2	2	2	-	-
CO5	3	3	2	1	1	-	-	2	-	2	2	2	-	-
3 – Strong, 2 – Medium, 1 - Low														

SEMESTER -IV

BM24401- BIOMEDICAL INSTRUMENTATION								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
IV	3	0	0	3	3	40	60	100

Course Objective

- To understand the basic theory of Bio potential Electrodes.
- To understand about the various bio signals and its electrode configuration.
- To understand the design of various bio amplifiers.
- To study the various non-electrical physiological parameter measurement.
- To explain about the various bio chemical measurements.

UNIT I - BIOPOTENTIAL ELECTRODES	**9**
Origin of bio potential and its propagation: Resting Potential Generation and Propagation of Action Potential, Conduction through nerve to neuromuscular junction. Bio Electrodes: Electrode-electrolyte interface, electrode- skin interface, half-cell potential, impedance, polarization effects of electrode - non polarizable electrodes, Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems -motion artifacts	
UNIT II - ELECTRODE CONFIGURATIONS	**9**
Bio signals characteristics - frequency and amplitude ranges. ECG - Einthoven's triangle, standard 12 lead system. EEG - 10-20 electrode system, unipolar, bipolar and average mode. EMG, ERG and EOG- unipolar and bipolar mode	
UNIT III - BIOPOTENTIAL AMPLIFIER	**9**
Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier - right leg driven ECG amplifier. Transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier	
UNIT IV - NON-ELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMENT	**9**
Temperature, respiration rate and pulse rate measurements, Plethysmography, Pulse oximetry, Blood Pressure: direct methods - Pressure amplifiers - systolic, diastolic, mean detector circuit, indirect methods - auscultatory method, Oscillo metric method, ultrasonic method. Blood flow - Electromagnetic and ultrasound blood flow measurement. Cardiac output measurement- Indicator dilution, dye dilution and thermodilution method	
UNIT V - BIOCHEMICAL MEASUREMENT	**9**
Biochemical sensors - pH, pO2 and pCO2, Ion selective Field Effect Transistor (ISFET), immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers, spectrophotometer, blood cell counter, auto analyzer	
Total Hours	**45**

Textbook(s)	
1	Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology", Pearson Education,4th Edition, 2014
2	John G. Webster, "Medical Instrumentation Application and Design", John Wiley and Sons, New York, 4th Edition, 2009
Reference(s)	
1	Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
2	L. A Geddes and L.E. Baker, "Principles of Applied Biomedical Instrumentation", John Wiley and Sons, 3rd Edition, Reprint 2008.
3	Leslie Cromwell, Fred J. Weibel, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Pearson Education India, 2nd Edition, 2015
4	Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Clarify the electrode behavior and circuit models	K2
CO2	Describe the fundamentals of electrode configurations.	K2
CO3	Design of various bio amplifiers.	K3
CO4	Explore about the various nonelectrical physiological parameter measurement methods	K4
CO5	Analyse about various biochemical parameters measurement	K4

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
CO2	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
CO3	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
CO4	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
CO5	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
3 – Strong, 2 – Medium, 1 – Low														

BM24421 - ARTIFICIAL INTELLIGENCE & MACHINE LEARNING								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
IV	3	0	2	5	4	50	50	100

Course Objective

- To Utilize the Fundamentals of Probability Distribution for Machine Learning
- To Formulate the Mathematical Foundation Behind Supervised and Unsupervised Learning
- To Apply the Supervised and Unsupervised Methods To Develop Decision Systems.

UNIT I - INTRODUCTION TO AI	**9**
Artificial intelligence (AI) -Foundation of AI-History-State of the art-problem solving by searching- problem solving agents-problem formulation-search-Breadth first-uniform-cost-Depth first-depth limited-Iterative depth-First search	
UNIT II - LEARNING TYPES AND METHODS	**9**
Components of Learning-Simple Learning Model-Types of Learning: Supervised, Unsupervised and Reinforcement- Other Views of Learning-Error and Noise-Error Measures-Noisy Targets	
UNIT III – REGRESSION	**9**
Introduction To Supervised Learning-Linear Regression-Algorithm-Univariate-Bivariate- Generalization Issues-Bias-Variance-Learning Curve-Over Fitting-Regularization-Case Study	
UNIT IV – CLASSIFICATION	**9**
Linear classification- Non separable data- logistic regression-Gradient Descent-Artificial neural network (ANN)-Single-layer feed forward-multi-layer feed forward-Back propagation-support vector machine (SVM)-case study	
UNIT V – CLUSTERING	**9**
General problem-k-mean clustering-choosing the k mixture models-EM algorithm-Gaussian mixture model-Bayesian network-case study	
Theory	**45**

PRACTICAL EXERCISES:

1. Implementation of Uninformed search algorithms (BFS, DFS).
2. Implementation of Informed search algorithms (A*, memory-bounded A*).
3. Implement naïve Bayes models.
4. Implement Bayesian Networks.
5. Build Regression models.
6. Build decision trees and random forests.
7. Build SVM models.
8. Implement ensembling techniques.
9. Implement clustering algorithms.
10. Implement EM for Bayesian networks.
11. Build simple NN models.
12. Build deep learning NN models.

Lab	**30**
Total Hours	**75**

Textbook(s)	
1	Stuarts Jonathan Russell, Stuart Russell, Peter Norvig, 'Artificial Intelligence: A Modern Approach", 4th Edition, Pearson 2020
2	Abu-Mostafa Y.S, Magdon-Ismali M, Lin H. T, "Learning from Data", 1st Edition, AML Book Publishers, 2012
Reference(s)	
1	Simon Rogers, Mark Girolamo, "A first Course in Machine Learning', 1st Edition CRC Press, 2011
2	Alpaydin Ethern, "Introduction to Machine Learning", 2nd Edition, MIT Press, 2014
3	UCI Machine learning repository, https://archieve.ics.uci.edu/

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Summarize the history and state of threat of AI	K2
CO2	Formulate the framework of machine learning models	K2
CO3	Understand the linear regression methods on any datasets	K2
CO4	Apply the architecture of neural networks and SVM	K3
CO5	Understand the various types of clustering methods	K2

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**1**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**
CO2	**3**	**1**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**
CO3	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**
CO4	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**
CO5	**3**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**
3 – Strong, 2 – Medium, 1 – Low														

BM24402 -BIOMEDICAL SIGNAL PROCESSING								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
IV	3	1	0	4	4	50	50	100

Course Objective

- To introduce the characteristics of different bio signals
- To discuss linear and non-linear filtering techniques to extract desired information
- To demonstrate the significance of wavelet detection applied in bio signal processing.
- To analyse the various events of biosignals.
- To introduce techniques for automated classification and decision making to aid diagnosis.

UNIT I – REVIEW OF SIGNALS AND SYSTEMS	**12**
Types of Signals, Transformation of Signals, LTI System Properties, Linear Convolution, Linear Correlation, Sampling Theorem, Discrete Time Fourier Transform, Properties, Z-Transforms, Systems- Definition-Classifications of Systems	
UNIT II – FOURIER TRANSFORM	**12**
Fourier transform definition-Properties of Fourier Transform- Energy Spectral Density-Parseval's Theorem-power spectral Density- Hilbert Transform & Properties	
UNIT III – DISCRETE TIME SIGNALS	**12**
Discrete Time Signals-Representation- Operations of Sequences- Classification-LTI System- Linear Convolution, Difference equation	
UNIT IV – FILTERING FOR REMOVAL OF ARTIFACTS	**12**
Time domain filtering (Synchronized Averaging, Moving Average): Derivative based operator- Frequency Domain Filtering: Notch Filter. Optimal Filter: Weiner Filter, Adaptive filtering. Removal of artifact - ECG, Average of Signals-PCG, ECG and EMG.	
UNIT V – WAVEFORM ANALYSIS	**12**
Morphological analysis of ECG, Correlation Co-efficient, Signal length, Envelope extraction, Amplitude Demodulation, Envelogram, Root means square value, Form Factor, Event detection -ECG, P Wave, QRS complex, T wave, Correlation analysis of ECG signals.	
Total Hours	**60**

Textbook(s)

1	John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing Algorithms and Applications", PHI of India Ltd., New Delhi, 3rd Edition 2000

2	Rangaraj. M.Rangayyan, "Biomedical signal processing", John Wiley & Sons, Inc., Hoboken, New Jersey.2nd edition,2015.
Reference(s)	
1	Oppenheim, Willsky & Young; Signals and Systems PHI, EEE, New Delhi, 2nd Edition, 2015
2	Raghuveer M. Rao and Ajith S. Bopardikar, Wavelets transform - Introduction to theory and its applications, Pearson Education, India 2000
3	Rangaraj M. Rangayyan, 2nd edition "Biomedical Signal Analysis-A case study approach", Wiley-Interscience /IEEE Press, 2015
4	Emmanuel C. Ifeachor, Barrie Jervis, second edition, "Digital Signal processing- A Practical Approach" Pearson education Ltd., 2002
5	Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Understand the basic concepts of Signals & Systems	K2
CO2	Interpret about the Properties of Fourier transform	K3
CO3	Analyze discrete time signals using various mathematical operations.	K3
CO4	Illustrate about the filtering and its application for biomedical signal	K4
CO5	Analyze the various morphological features of ECG.	K4

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**-**
CO2	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**-**
CO3	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**-**
CO4	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**-**
CO5	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**-**
3 – Strong, 2 – Medium, 1 – Low														

BM24422- VIRTUAL REALITY AND AUGMENTED REALITY IN MEDICAL APPLICATIONS								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
IV	3	0	2	5	4	50	50	100

Course Objective

- Understand the technologies, components and interfaces in VR.
- Know the intricacies of these platform to develop PDA applications with better optimality.
- Learn the possibilities of implementing target-specific VR applications on mobile.
- Learn the various applications of VR.

UNIT I INTRODUCTION The three I's of virtual reality-commercial VR technology and the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position	**09**
trackers, navigation and manipulation-interfaces and gesture interfaces-Output Devices: Graphics displays-sound displays & haptic feedback.	
UNIT II VR DEVELOPMENT PROCESS Geometric modeling - kinematics modeling- physical modeling - behavior modeling - model management.	**09**
UNIT III CONTENT CREATION CONSIDERATIONS Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment	**09**
UNIT IV VR ON THE WEB & VR ON THE MOBILE JS-pros and cons-building blocks (WebVR, WebGL, Three.js, device orientation events)- frameworks (A-frame, React VR)-Google VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial audio-Assessing human parameters-device development and drivers-Design Haptics	**09**
UNIT V APPLICATIONS Medical applications-military applications-robotics applications- Advanced Real time Tracking-other applications- games, movies, simulations, therapy, Game Development Tool.	**09**
Theory	**45**
Practical Exercises	

1. Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same. 2. Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR. 3. Develop a scene in Unity that includes: i. a cube, plane and sphere, apply transformations on the 3 game objects. ii. add a video and audio source. 4. Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the colour, material and texture of each Game object separately in the scene. Write a C# program in visual studio to change the colour and material/texture of the game objects dynamically on button click. 5. Develop a scene in Unity that includes a sphere and plane. Apply Rigid body component, material and Box collider to the game Objects. Write a C# program to grab and throw the sphere using VR controller. 6. Create an immersive environment (living room/ battlefield/ tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models. 7. Develop a simple UI (User interface) menu with images, canvas, sprites and button. Write a C# program to interact with UI menu through VR trigger button such that on each successful trigger interaction display a score on scene.	
Lab	**30**
Total Hours	**75**

Textbook(s)

1	C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc.,2008 2. Jason Jerald. 2015. The VR Book: Human-Centered Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.

Reference(s)

1	Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575
2	Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability), Steve Aukstakalnis, Addison-Wesley Professional; 1 edition, 2016.
3	The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything, Robert Scoble & Shel Israel, Patrick Brewster Press; 1 edition, 2016.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Gain knowledge about the basics of virtual reality and augmented reality	K2
CO2	Explain about the VR development process.	K2
CO3	Analyze the implications and issues pertaining to VR	K4
CO4	Interpret about the VR on mobile and web.	K2

CO5	Explore applications and future trends of ARVR in various fields.	K4

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**1**
CO2	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**1**
CO3	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**1**
CO4	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**1**
CO5	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**1**
3 – Strong, 2 – Medium, 1 – Low														

BM24403- BIO CONTROL SYSTEM								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
IV	3	0	0	3	3	40	60	100

Course Objective

- To understand the concept behind basics of bio control systems.
- To analyse the process regulation.
- Design and analysis of thermal regulatory system
- Gain knowledge about the biocontrol system mechanism for organs like heart, lungs, Endocrine system.
- Gain knowledge about the biocontrol system mechanism of Endocrine system and limbs.

UNIT I - INTRODUCTION TO BIO CONTROL SYSTEM	**9**
Introduction: Technological control system, transfer function, mathematical approaches, system stability, introduction to biological control system, Modeling and block diagram, closed loop dynamics of first order and second order control system, similarities between biological and engineering control system, biological receptors and receptor characteristics	
UNIT II - PROCESS REGULATION	**9**
Acid-base balance, extra-cellular water and electrolyte, interstitial fluid volume, blood pressure, blood glucose, CO2.	
UNIT III - MODELING OF HUMAN THERMAL REGULATORY SYSTEM	**9**
Parameters involved, control system model etc. Biochemistry of digestion, types of heat loss from body, models of heat transfer between subsystems of human body like skin - core etc. and systems like within body, body environment.	
UNIT IV - BIOLOGICAL CONTROL I	**9**
Cardiac rate, blood pressure, respiratory rate, mass balancing of lungs, oxygen uptake by RBC and pulmonary capillaries, oxygen and carbon dioxide transport in blood and tissues.	
UNIT V - BIOLOGICAL CONTROL II	**9**

Urine formation and control, Pupil control systems, skeletal muscle servomechanism and semicircular canal. Free swinging limbs, Endocrine control system		
	Total Hours	**45**
Textbook(s)		
1	I.J. Nagarath and M. Gopal, Control Systems Engineering, New Age International Publishers, 1st September, 2018.	
2	A.Nagoor kani, Control System Engineering, RBA Publications, 2nd Edition, 2017	
Reference(s)		
1	Salivahanan S. Rengaraj R. and Venkatakrishnan G. R., Control Systems Engineering, Pearson Education India, 2015.	
2	Michael C K Khoo, Physiological Control Systems, IEEE Press, Prentice Hall India, 2005.	

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Understand about the basics concepts of Bio control system	K1
CO2	Elaborate about the Process Regulation	K2
CO3	Explore the modelling for thermal regulatory system	K4
CO4	Derive about the control system for heart and lungs	K3
CO5	Demonstrate about the control system for Kidney and Limbs	K3

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
CO2	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
CO3	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
CO4	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
CO5	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**
3 – Strong, 2 – Medium, 1 – Low														

BM24404 - BIOMECHANICS								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIA	ESE	Total
V	3	0	0	3	3	40	60	100

Course Objective

- Learn the fundamental concepts of the principles of mechanics.
- Understand the basics of biofluid mechanics.
- Review the mechanical properties of musculoskeletal elements.
- Study the biomechanics of joints and implants.
- • Learn the application of biomechanics into modelling and ergonomic design.

UNIT I - INTRODUCTION TO MECHANICS	**9**
Principles of Mechanics, Vector mechanics, Mechanics of motion - Newton's laws of motion, Kinetics, Kinematics of motion, Fluid mechanics - Euler equations and Navier Stroke's equations, Viscoelasticity, Constitutive equations, Stress transformations, Strain energy function.	
UNIT II - BIOFLUID MECHANICS	**9**
Newtonian viscous fluid, non-viscous fluid - Rheological properties of blood -Structure and composition of blood vessel - Remodeling of blood vessels -Nature of fluids, Propulsion in fluid medium - Mechanical properties of arterioles, capillary vessels and veins - Bio-viscoelastic solids- Measurement techniques.	
UNIT III - BIOSOLID MECHANICS	**9**

Hard Tissues: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models - anisotropy. Soft Tissues: Structure, functions, material properties and modelling of Soft Tissues: Cartilage, Tendon, Ligament, Muscle.	
UNIT IV - MECHANICS OF JOINTS	**9**
Skeletal joints, forces and stresses in human joints, types of joints, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle.	
UNIT V - ERGONOMICS	**9**
Ergonomics- Gait analysis, Design of work station, Sports biomechanics, Injury mechanics.	
Total Hours	**45**

Textbook(s)

1	Y.C. Fung, "Bio-Mechanics- Mechanical Properties of Tissues", Springer-Verlag, 1998.
2	Subrata Pal, "Textbook of Biomechanics", Viva Books Private Limited, 2009.

Reference(s)

1	Krishna B. Chandran, Ajit P. Yoganathan and Stanley E. Rittgers, "Biofluid Mechanics: The Human Circulation", Taylor and Francis, 2nd Edition, 2012.
2	Jay D. Humphrey, Sherry De Lange, "An Introduction to Biomechanics: Solids an84444d Fluids, Analysis and Design", Springer Science Business Media, 2004.
3	Shrawan Kumar, "Biomechanics in Ergonomics", Second Edition, CRC Press 2007.
4	Duane Knudson, "Fundamentals of Biomechanics", Springer, 2nd edition, 2007.
5	Schneck D J, and Bronzino J D, "Biomechanics- Principles and Applications", CRC Press, 2nd Edition, 2000.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Explain the fundamental principles of mechanics	K2
CO2	Describe the basics of biofluid mechanics as applied to heart valve design and blood vessel models.	K2
CO3	State the basics of bio-solid mechanics.	K1
CO4	Apply the knowledge of joint mechanics.	K1
CO5	Interpret design concepts of Orthopedic based applications.	K5

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**1**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**
CO2	**3**	**1**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**
CO3	**3**	**1**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**
CO4	**3**	**1**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**
CO5	**3**	**1**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**
3 – Strong, 2 – Medium, 1 – Low														

BM24405 - TESTING AND CALIBRATION OF MEDICAL EQUIPMENTS								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIAT	ESE	Total
IV	3	0	0	3	0	-	-	-

Course Objective

- To understand the maintenance, troubleshooting & repair of diagnostic devices.
- To understand the maintenance, troubleshooting & repair of therapeutic devices
- To illustrate the testing of different Equipment of sterilization departments.
- To explain about the importance of electrical safety Analyzer
- To explain about the quality standards followed by Hospitals.

UNIT I - MAINTENANCE OF DIAGNOSTIC MEDICAL EQUIPMENT	**9**
Basics of the device; Device and Components, how to perform Preventive Maintenance - troubleshooting, repair, and testing of different diagnostic device.	
UNIT II - MAINTENANCE OF THERAPEUTIC MEDICAL EQUIPMENT	**9**
Maintenance, the troubleshooting, and repair of ventilators, operation theatre lights, oxygen concentrators, electro-surgical units, anesthesia machines, and suction machines.	
UNIT III - STERILISATION AND LABORATORY EQUIPMENTS MAINTENANCE	**9**
Autoclave-Centrifuge-Analyser and colorimeter-Microscope-Electrolyte analyser-Blood cell counter- Incubator	
UNIT IV - SAFETY ANALYSER	**9**
Electrical safety tests - O_2 Saturation - Heart rate - Pulse amplitude - Selectable pigmentation and ambient light condition-Electrical safety tests - ECG - Blood pressure - Cardiac Output - Respiration - Temperature - Pacemaker recognition	
UNIT V - STANDARDIZATION OF QUALITY IN HOSPITALS	**9**
Define Quality- Need for Standardization & Quality Management, QM in Health care organization-Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services - Classification of Equipments.	
Total Hours	**45**

Textbook(s)

1	Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology", Pearson Education,4th Edition, 2014
2	John G. Webster, "Medical Instrumentation Application and Design", John Wiley and Sons, New York, 4th Edition, 2009

Reference(s)

1	Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice Hall of India, New Delhi, 2015.

2	Richard Aston “Principles of Biomedical Instrumentation and Measurement”, Merril Publishing Company, 1990.
3	L.A Geddes and L.E. Baker “Principles of Applied Biomedical Instrumentation” 2004.
4	Myer Kutz “Standard Handbook of Biomedical Engineering & Design”, McGraw-Hill Publisher, 2003.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Understand the maintenance, troubleshooting & repair of diagnostic devices.	K2
CO2	Elaborate the maintenance, troubleshooting & repair of therapeutic device	K2
CO3	Illustrate the testing of different Equipments of sterilization departments.	K2
CO4	Explain about the importance of electrical safety Analyzer	K3
CO5	Extend about the quality standards followed by Hospitals	K2

BM24411 - BIOMEDICAL SIGNAL PROCESSING LABORATORY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIA	ESE	Total
IV	0	0	2	4	2	60	40	100

Course Objective

- Analysis of ECG, EEG and EMG.
- Design of different filters for filtering the bio signals.

LIST OF EXPERIMENTS	
1. Representation of basic signals	
2. Linear convolution	
3. Autocorrelation and cross correlation	
4. FFT and IFFT	
5. Difference equation Representation	
6. Digital IIR Butterworth filter-LPF & HPF	
7. Digital IIR Chebyshev filter-LPF & HPF	
8. Design of FIR filter using windowing technique	
9. Up sampling and down sampling	
10. QRS detection, RR interval calculation of ECG.	
11. Analysis of EEG	
12. Identification of various sounds from PCG.	
Total Hours	**60**

Reference(s)

1	Ramesh Babu, "Digital Signal Processing, Sixth Edition, SciTech publications, Chennai, 2014
2	Raghuveer M. Rao and Ajith S. Bopardikar, Wavelets transform - Introduction to theory and its applications, Pearson Education, India 2000

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Understand the basic representations of signals	K2
CO2	Analyse the Convolution and Correlation	K3
CO3	Compute the various parameters of bio signals like ECG, EEG and PCG	K3
CO4	Design the different types of filters	K6
CO5	Characterize about the different sampling methods	K4

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**-**
CO2	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**-**
CO3	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**-**
CO4	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**-**
CO5	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**-**
3 – Strong, 2 – Medium, 1 – Low														

BM24412- BIOMEDICAL INSTRUMENTATION LABORATORY								
Semester	Hours/Week			Total Hours	Credit	Maximum Marks		
	L	T	P		C	CIA	ESE	Total
IV	0	0	2	4	2	60	40	100

Course Objective

- To study and design Bio amplifiers.
- To provide hands on training on Measurement of physiological parameters.

LIST OF EXPERIMENTS	
1. Measurement of blood pressure.	
2. Design and testing of preamplifiers for various biomedical instruments.	
3. Development of ECG amplifiers and filters.	
4. Recording of ECG signal.	
5. Measurement of respiratory parameters using spirometer.	
6. Recording of EMG-Signal.	
7. Recording of EEG-Signal.	
8. Recording EEG with stimulus.	
9. Heart sound measurement using PCG.	
10. Galvanic skin resistance (GSR) measurement.	
11. Design a PCB layout for any bio amplifier using suitable software tool.	
12. Measurement of pH and conductivity	
13. Measurement of pulse-rate using Photo transducer.	
14. Measurement and recording of peripheral blood flow.	
15. Design and study the characteristics of optical Isolation amplifier	
Total Hours	**60**

Reference(s)

1	John G. Webster, "Medical Instrumentation Application and Design", John Wiley and Sons, New York, 4th Edition, 2009
2	Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill.

On the successful completion of the course, students will be able to

Course Outcome		Level
CO1	Measure of Bio signal using electrodes	K5
CO2	Design of bio amplifier using PCB layout	K6
CO3	Record and analyze pulse rate and respiration rate	K4
CO4	Measure blood pressure and blood flow using transducer	K5
CO5	Design and study of isolation amplifier	K6

Mapping with Program Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**3**	**1**	**1**	**1**	**1**			**1**	**1**	**1**	**1**		**1**
CO2	**3**	**3**	**1**	**1**	**1**	**1**			**1**	**1**	**1**	**1**		**1**
CO3	**3**	**3**	**1**	**1**	**1**	**1**			**1**	**1**	**1**	**1**		**1**
CO4	**3**	**3**	**1**	**1**	**1**	**1**			**1**	**1**	**1**	**1**		**1**
CO5	**3**	**3**	**1**	**1**	**1**	**1**			**1**	**1**	**1**	**1**		**1**
3 – Strong, 2 – Medium, 1 - Low														