HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

B. TECH. CHEMICAL ENGINEERING

(Duration: 4 Years)

CURRICULUM and SYLLABUS

(Applicable for Students admitted from Academic Year 2022-23)

DEPARTMENT OF CHEMICAL ENGINEERNG

SCHOOL OF MECHANICAL SCIENCES

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

Motto:

To Make Every Man *a* Success *and* No Man *a* Failure

Vision:

To be an International Institute of Excellence, providing a conducive environment for education with a strong emphasis on innovation, quality, research and strategic partnership blended with values and commitment to society.

Mission:

- *To create an ecosystem that promotes learning and world class research.*
- *To nurture creativity and innovation.*
- *To instil highest ethical standards and values.*
- *To pursue activities for the development of the Society.*
- *To develop national and international collaborations with institutes and industries of eminence.*
- *To enable graduates to become future leaders and innovators.*

Value Statement:

Integrity, Innovation, Internationalization.

DEPARTMENT OF CHEMICAL ENGINEERING

Vision:

To achieve the pinnacle of success through quality education, research and entrepreneurship in emerging areas of Chemical Engineering and Biotechnology.

Mission:

- *To provide innovative education empowered with excellent technical and leadership skills*
- *To create state-of-the-art infrastructure for research and training, promote scientific discovery and development by fostering relationship with research organizations and industries.*

PROGRAMME'S EDUCATIONAL OBJECTIVES (PEO'S):

***PEO1**. Succeed in the application of chemical engineering or advanced studies in engineering, scientific, or complementary disciplines.*

***PEO2**. Undertake premier roles in industry and/or in technological fields.*

***PEO3.**Contribute to the socio-economic environment of their communities.*

***PEO4**. Develop knowledge and skills continuously through life-long learning.*

***PEO5.**Practice and adhere to principles of professional ethics.*

PROGRAMME'S OUTCOMES (PO'S):

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

PO-2: *Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.*

PO-3: *Design processes for complex biotechnological problems that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.*

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

PO-5: *Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.*

PO-6: *Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the biotechnological practice.*

PO-7: *Understand the impact of biotechnology in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.*

PO-8: *Apply ethical principles and commit to professional ethics and responsibilities and norms of the biotechnological practice.*

PO-9: *Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.*

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

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

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

PROGRAMME'S SPECIFIC OUTCOMES (PSO'S):

PSO-1*: The ability to predict the outcome of a given heat or mass transfer process using the molecular and diffusive transport mechanisms.*

PSO-2*: Develop process or product design incorporating performance requirements.*

PSO-3*: Integrate thermodynamic principles to develop mathematical models for catalytic multi-phase reactions.*

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE (DEEMED TO BE UNIVERSITY)

B.TECH CHEMICAL ENGINEERING

FRAMEWORK OF CURRICULUM 2022 (in line with NEP 2020)

SEMESTER –I

SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	EMA51001	Matrices and Calculus	3	0	2	4	2	5
2	BS	EPH51001	Engineering Physics	3	0	2	4	2	5
3	PC	ECS51002	Programming in Python	3	0	2	4	1	5
4	ES	EME51001	Engineering Graphics and Computer Aided Design	2	0	2	3	1	4
5	HS	ELS51002	Personality Development and Soft Skills	1	0	2	2	1	3
6	ES	ECH51400	FAB Lab for Chemical Engineers	0	1	2	2	2	3
7	HS	EGE51400/ EGE51401/ EGE51402/ EGE51403	Fine Arts (Drawing)/ Fine Arts (Singing)/Fine Arts (Dance)/ Fine Arts (Music)	0	0	2	1	0	2
8	PC	ECH51402	Design Thinking for Chemical Engineers	0	1	2	2	1	3
Total				**12**	**2**	**16**	**22**	**10**	**30**

SEMESTER –II

SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	EMA51002	Analytical Mathematics	3	0	2	4	2	5
2	BS	ECT51001	Engineering Materials	3	0	2	4	2	5
3	PC	ECH51001	Instrumental Analysis for Engineers	2	1	2	4	1	5
4	HS	EGE51001	Universal Human Values	2	0	0	2	1	2
5	HS	ELS51001	Communication Skills	2	0	2	3	1	4
6	ES	ECH51401	Innovation Lab for Chemical Engineers	0	1	2	2	2	3
7	HS	EGE51404/ EGE51405	Outreach (NCC)/ Outreach (NSS)	0	0	2	1	0	2
8	HS	ELS51003/ ELS51004/ ELS51005	Regional Language (Tamil)/ Regional Language (Hindi)/ Regional Language (Telugu)	2	0	0	2	1	2
Total				**14**	**2**	**12**	**22**	**10**	**28**

FRAMEWORK OF CURRICULUM 2022 (in line with NEP 2020)									
SEMESTER –III									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OFTHE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	EMA510X	Partial Differential Equations and Transforms	3	1	0	4	2	4
2	PC	ECH51002	Mechanical Operations	3	0	2	4	1	5
3	PC	ECH51003	Chemical Process calculations	2	1	0	3	1	3
4	DE	ECH51XXX	DE 1	2	0	2	3	0	4
5	NE	ECH51XXX	NE 1	2	0	2	3	0	4
6	EEC	ECH51800	Design Project –1	0	0	2	1	2	2
7	ES	ECH51004	Sustainable Engineering Systems (Program Specific)	2	0	0	2	2	2
8	EEC	ECH51801	Internship-1(To be carried out in summer after 2nd semester and evaluated in 3rd semester)	0	0	0	1	2	0
		Total		**14**	**2**	**8**	**21**	**10**	**24**
SEMESTER –IV									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	EMA510X	Numerical Methods	3	1	0	4	2	4
2	PC	ECH51005	Fluid Mechanics	2	1	2	4	2	5
3	PC	ECH51006	Chemical Process Heat Transfer	2	0	2	3	2	4
4	DE	ECH51XXX	DE 2	2	0	2	3	0	4
5	NE	ECH51XXX	NE 2	2	0	2	3	0	4
6	EEC	ECH51802	Design Project – 2	0	0	2	1	2	2
7	PC	ECH51007	Industry Collaborated Course – Petroleum Refining and Petrochemicals	2	0	2	3	2	4
8	PC	ECH51008	Scale-Up Methods	3	0	0	3	2	3
		Total		**16**	**4**	**8**	**24**	**12**	**28**

FRAMEWORK OF CURRICULUM 2022 (in line with NEP 2020)									
SEMESTER –V									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	ECH51009	Chemical Engineering Thermodynamics	3	1	0	4	2	4
2	PC	ECH51010	Chemical Reaction Engineering	2	1	2	4	2	5
3	PC	ECH51011	Mass Transfer	3	0	0	3	2	3
4	DE	ECH51XXX	DE 3	2	0	2	3	0	4
5	NE	ECH51XXX	NE 3	2	0	2	3	0	4
6	EEC	ECH51803	Design Project –3	0	0	2	1	2	2
7	ES	ECH51012	Entrepreneurship	1	0	2	2	0	3
8	EEC	ECH51804	Internship -2 (to be evaluated in 5th semester. To be carried out in summer after 4th semester)	0	0	0	1	2	0
Total				**13**	**2**	**10**	**21**	**10**	**25**
SEMESTER –VI									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	ECH51013	Process Dynamics and Control	2	1	2	4	2	5
2	PC	ECH51014	Separation Process	2	1	0	3	2	3
3	PC	ECH51015	Heterogeneous Reaction Engineering	2	1	0	3	2	3
4	DE	ECH51XXX	DE 4	2	0	2	3	0	4
5	NE	ECH51XXX	NE 4	2	0	2	3	0	4
6	PC	ECH51016	Case Study / Field Study / Product study	2	0	2	3	2	4
7	EEC	ECH51805	Design Project –4	0	0	2	1	2	2
8	HS	ECH51XXX	Skill Development and Career Planning	0	0	2	1	2	2
Total				**12**	**3**	**12**	**21**	**12**	**27**

FRAMEWORK OF CURRICULUM 2022 (in line with NEP 2020)									
SEMESTER –VII									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	ECH51017	Process Modeling and Simulation	2	1	2	4	2	5
2	PC	ECH51018	Chemical Process Equipment Design	2	1	0	3	2	3
3	PC	ECH51019	Transport Phenomena	2	1	0	3	2	3
4	DE	ECH51XXX	DE 5	2	0	2	3	0	4
5	NE	ECH51XXX	NE 5	2	0	2	3	0	4
6	PC	ECH51020	Term Paper on Research Findings	2	0	0	2	2	2
7	ES	ECH51XXX	Research Methodology & IPR	2	0	0	2	2	2
8	EEC	ECH51806	Project Work Phase 1	0	0	6	3	2	6
Total				**14**	**3**	**12**	**23**	**12**	**29**
SEMESTER –VIII									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	EEC	ECH51807	Project Work Phase 2	0	0	22	11	4	22
Total				**0**	**0**	**22**	**11**	**4**	**22**
Total Credits for the Program							**165**		

CREDIT COUNT

Semester	Credit Count
1	22
2	22
3	21
4	24
5	21
6	21
7	23
8	11
	165

LIST OF DEPARTMENTAL ELECTIVES WITH GROUPING - SEMESTER WISE

SEM	COURSE	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
Elective 1									
3	DE	ECH51500	Chemical Process Industries - Inorganic Materials [1]	2	0	2	3	0	4
3	DE	ECH51501	Electrochemical Engineering [2]	2	0	2	3	0	4
3	DE	ECH51502	Food Processing Technology [3]	2	0	2	3	0	4
3	DE	ECH51503	Water Treatment Technology	2	0	2	3	0	4
Elective 2									
4	DE	ECH51504	Chemical Process Industries - Organic materials [1]	2	0	2	3	0	4
4	DE	ECH51505	Fuel Cell Engineering [2]	2	0	2	3	0	4
4	DE	ECH51506	Glass and Ceramic Technology [3]	2	0	2	3	0	4
4	DE	ECH51507	Industrial pollution and control [4]	2	0	2	3	0	4
Elective 3									
5	DE	ECH51508	Fluidization Engineering [1]	2	0	2	3	0	4
5	DE	ECH51509	Principles of nanotechnology [2]	2	0	2	3	0	4
5	DE	ECH51510	Pharmaceutical Technology [3]	2	0	2	3	0	4
5	DE	ECH51511	Environmental Remediation [4]	2	0	2	3	0	4
Elective 4									
6	DE	ECH51512	Biochemical Engineering [1]	2	0	2	3	0	4
6	DE	ECH51513	Industrial Catalysis [2]	2	0	2	3	0	4
6	DE	ECH51514	Polymer Science &Technology [3]	2	0	2	3	0	4
6	DE	ECH51515	Safety and Hazard management in Chemical Industries [4]	2	0	2	3	0	4
Elective 5									
7	DE	ECH51516	Process Instrumentation [1]	2	0	2	3	0	4
7	DE	ECH51517	Hydrogen Energy: Production and Storage [2]	2	0	2	3	0	4
7	DE	ECH51518	Pulp and Paper Technology [3]	2	0	2	3	0	4
7	DE	ECH51519	Modern Separation Processes [4]	2	0	2	3	0	4

[1] PROCESS TECHNOLOGY; [2] SUSTAINABLE ENERGY; [3] PRODUCT ENGINEERING; [4] ENVIRONMENT HEALTH AND SAFETY

LIST OF NON-DEPARTMENTAL ELECTIVES OFFERED WITH GROUPING - SEMESTER WISE

SEM	COURSE	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
Elective 1									
3	NE	ECH51700	Waste to Energy	2	0	2	3	0	4
3	NE	ECH51701	Fuels & Furnaces	2	0	2	3	0	4
Elective 2									
4	NE	ECH51702	Green Technology	2	0	2	3	0	4
4	NE	ECH51703	Environment Health & Safety (EHS)	2	0	2	3	0	4
Elective 3									
5	NE	ECH51704	Fertilizer Technology	2	0	2	3	0	4
5	NE	ECH51705	Renewable Energy Source	2	0	2	3	0	4
Elective 4									
6	NE	ECH51706	Pollution Control in Process Industries	2	0	2	3	0	4
6	NE	ECH51707	Water Science and Engineering	2	0	2	3	0	4
Elective 5									
7	NE	ECH51708	Energy Engineering	2	0	2	3	0	4
7	NE	ECH51709	Industrial Waste Management	2	0	2	3	0	4

SEMESTER - I

COURSE TITLE	MATRICES AND CALCULUS (Common to ALL B. Tech)			CREDITS	4
COURSE CODE	EMA51001	COURSE CATEGORY	BS	L-T-P-S	3-0-2-2
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME						
CIA					ESE	
First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Practical Assessments	Observation / Lab records as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (Theory)	End Semester Examination (Practical)
15%	15%	10%	5%	5%	25%	25%

Course Description	To make the student understand the basic concepts of matrices and calculus using MATLAB
Course Objective	1. To perform some simple operations on matrices 2. To give a strong foundation on the basic concepts of differentiation and integration. 3. To demonstrate the fundamental understanding of integrals 4. To classify ordinary differential equations. 5. To impart the knowledge of sequences and summation of series.
Course Outcome	Upon completion of this course, the students will be able to 1. Calculate the inverse of the matrix using Cayley Hamilton theorem and diagonalize the matrix 2. Determine the derivative and higher derivatives of a given function explicitly and integrate the standard functions using suitable differentiation and integration formulae 3. Evaluate surface area and volume using multiple integrals 4. Compute the solution of second order the differential equations 5. Determine the convergence and divergence of the sequence using the appropriate tests.

Prerequisites: Knowledge in calculus at high secondary level.

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-	3	3	1	-	1	-	-	-	-	-	-	1	To be marked by		

1													**respective department**
CO-2	**3**	**3**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	
CO-3	**3**	**3**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	
CO-4	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	
CO-5	**3**	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:MATRICES	**(9L+6P)**
Characteristic equation – Eigen values and Eigenvectors – Properties – Cayley Hamilton theorem (Statement only) – Verification and inverse of the matrix using Cayley Hamilton theorem- Diagonalization of matrices using similarity transformation Suggested Reading: Basics of Matrices **Lab: Eigen values and Eigenvectors, Verification and inverse using Cayley Hamilton theorem- Diagonalization**	**CO-1** **BTL-3**
MODULE 2: DIFFERENTIAL AND INTEGRAL CALCULUS	**(9L+6P)**
Basic Concepts and Simple Problems in Differentiation and Integration-Partial differentiation – Total differentiation- Taylor's series – Maxima and minima of functions of two variables. Integration – Methods of integration – Substitution method – Integration by parts – Integration using partial fraction – Bernoulli's formula. Suggested Reading: Basics of differentiation and integration. **Lab: Taylor's series – Maxima and minima of functions of two variables, Integration using partial fraction**	**CO-2** **BTL-3**
MODULE 3: MULTIPLE INTEGRAL	**(9L+6P)**
Double integration – Cartesian and polar co-ordinates – Change of order of integration. Area as a double integral – Triple integration in Cartesian coordinates – Volume as a triple integral - Change of variables between Cartesian and polar coordinates. Suggested Reading: Line Integrals **Lab: Area and Volume of double integration and triple integration.**	**CO-3** **BTL-3**
MODULE 4: ORDINARY DIFFERENTIAL EQUATIONS	**(9L+6P)**

Second order differential equations with constant coefficients – Particular integrals $-e^{ax}$, $cosax$, $\sin ax, x^m, e^{ax}cosbx$, $e^{ax}sinbx$, Solutions of homogeneous differential equations with variable coefficients – Variation of parameters. Suggested Reading: Basics of Differential Equations. **Lab: Solution of Second order differential equations.**	**CO-4** **BTL-3**
MODULE 5: SEQUENCE AND SERIES	**(9L+6P)**
Definition of Sequence and series with examples, Convergence, divergence and Oscillation of sequence and series, properties, Tests for convergence of series (Comparison test, Limit Comparison test , Integral test, Ratio test, D' Alembert's test, Alternating Series). Suggested Reading: Basics of sequence and series. **Lab: Test the convergence and divergence.**	**CO-5** **BTL-3**

TEXT BOOKS	
1.	A. Chandrasekaran, G Kavitha (2019), *Matrices and Calculus*, Dhanam Publications, 1st Edition, Chennai.
2.	B.S. Grewal (2017), *Higher Engineering Mathematics*, Khanna Publishers, 43rd Edition, New Delhi.
3.	A. P. Santhakumaran, P. Titus P (2017), *Engineering Mathematics – II*, NiMeric Publications, 2nd Edition, Nagercoil, India.
REFERENCE BOOKS	
1.	D. G. Duffy (2021), *Advanced Engineering Mathematics With MATLAB (Advances in Applied Mathematics)*, Chapman and Hall Publisher, 5th Edition, CRC Press, USA.
2.	M. D. Weir, Joel Hass, Thomas (2016), *Calculus*, Pearson Publication, 12th Edition, India.
3.	Srimantha Pal and S.C. Bhunia (2015), *Engineering Mathematics*, Oxford University Press, 1st Edition, New Delhi, India.
E BOOKS	
1. **2.**	https://www.elsevier.com/books/matrix-calculus/bodewig/978-1-4832-3214-0 https://www.ebooks.com/en-er/book/209983367/matrix-calculus-kronecker-product-and-tensor-product-a-practical-approach-to-linear-algebra-multilinear-algebra-and-tensor-calculus-with-software-implementations-third-edition/yorick-hardy/
MOOC	
1. 2.	https://www.coursera.org/learn/introduction-to-calculus https://nptel.ac.in/courses/111105035

<table>
<tr><td>COURSE TITLE</td><td colspan="3">ENGINEERING PHYSICS
(Common to ALL branches of Engineering)</td><td>CREDITS</td><td>4</td></tr>
<tr><td>COURSE CODE</td><td>EPH51001</td><td>COURSE CATEGORY</td><td>BS</td><td>L-T-P-S</td><td>3-0-2-2</td></tr>
<tr><td>Version</td><td>1.0</td><td>Approval Details</td><td></td><td>LEARNING LEVEL</td><td>BTL3</td></tr>
<tr><td colspan="6">ASSESSMENT SCHEME</td></tr>
<tr><td>First Periodical Assessment (Theory)</td><td>Second Periodical Assessment (Theory)</td><td>Practical Assessments</td><td>Observation / lab records as approved by the Department Examination Committee “DEC”</td><td>Attendance</td><td>End Semester Examination</td></tr>
<tr><td rowspan="2">15%</td><td rowspan="2">15%</td><td rowspan="2">10%</td><td rowspan="2">5%</td><td rowspan="2">5%</td><td>Theory 25%</td></tr>
<tr><td>Practical 25%</td></tr>
<tr><td>Course Description</td><td colspan="5">This course is based on the developing areas of physics integrating both the theoretical and practical training for engineering students. Application of the concepts to solve engineering problems, to acquire practical thinking and logical reasoning.</td></tr>
<tr><td>Course Objective</td><td colspan="5">1. To evaluate various types of modulus of elasticity and impart knowledge on production and application of ultrasonic wave in SONAR and NDT.
2. To provide a strong foundation on the concepts of crystal physics and thermal conductivity.
3. To illustrate theoretically and experimentally the wave – particle duality.
4. To evaluate the material properties based on energy band gap and magnetic moment.
5. To make the students understand the production of lasers and propagation of light through an optical fiber.</td></tr>
<tr><td>Course Outcome</td><td colspan="5">Upon completion of this course, the students will be able to
1. Evaluate the elastic properties of materials and apply the properties of ultrasonic waves for industrial applications
2. Evaluate the characteristics of crystal structure and the thermal conductivity of good and bad conductors.
3. Solve the Schrodinger’s wave equations and derive energy density based on Planck’s hypothesis
4. Apply the fundamental concepts to classify magnetic and semiconducting materials and thereby, illustrate their applications.
5. Apply lasers and optical fibers as engineering tools</td></tr>
<tr><td colspan="6">Prerequisites: Knowledge in fundamentals of Physics at higher secondary level</td></tr>
</table>

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO	PO	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	3	-	-	3	To be marked by respective department.		
CO2	3	3	-	2	3	-	-	-	3	-	-	3			
CO3	3	3	-	-	1	-	-	-	3	-	-	3			
CO4	3	3	-	2	-	-	-	-	3	-	-	3			
CO5	3	3	-	-	3	-	-	-	3	-	-	3			

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF MATTER AND ULTRASONICS	**(9L + 6P)**
Elasticity – Hooke's law – Elastic Moduli – Young's modulus of elasticity – Rigidity modulus - Bulk modulus – Twisting couple on a wire – Torsional pendulum – Determination of rigidity modulus of a wire – Depression of a cantilever – Non-uniform bending – Uniform bending – I shape girder. Introduction – Production of ultrasonic waves (Magnetostriction and Piezoelectric methods) – Properties of ultrasonic – Applications in SONAR and NDT. **Practical component:** Torsional pendulum – Determination of rigidity modulus of thin wire and moment of inertia of regular objects Non-uniform bending – Determination of Young's modulus of wooden beam	**CO1** **BTL3**
MODULE 2: CRYSTALLOGRAPHY AND THERMAL PHYSICS	**(9L + 6P)**
Amorphous and crystalline solids – Unit cell – Lattice parameters – Crystal system and Bravais lattices (Qualitative) – Miller indices – Interplanar spacing for cubic crystal system – Crystal structures SCC, BCC, FCC, HCP (no. of atoms, coordination number, atomic packing fraction calculations) – Bragg's law – X-ray diffractometer. Thermal conductivity – Experimental determination of thermal conductivities of good and bad conductors – Forbe's method (Theory and experiment) – Lee's disc method for bad conductors. **Practical component:** Lee's disc experiment – Determination of thermal conductivity of bad conductor	**CO2** **BTL3**
MODULE 3: QUANTUM PHYSICS	**(9L + 6P)**
Black body radiation – Planck's hypothesis – Photoelectric effect – Compton effect – Theory and experimental verification Physical significance of wave function – Schrodinger's wave equation – Time independent and time dependent equations – Particle in a 1D box – Quantum Well (no derivation) **Practical component:** Photoelectric effect – To plot the KE as a function of frequency for different metals.	**CO3** **BTL3**
MODULE 4: MAGNETISM AND SEMICONDUCTORS	**(9L + 6P)**
Magnetic moment – Classification of magnetic materials (Dia, para, ferro, anti-ferro) –	**CO4**

Domain theory of ferromagnetism – Hysteresis – Hard and soft magnetic materials – Memory applications. Classification of semiconductors – Direct and in-direct bandgap – Fermi energy level – Intrinsic and extrinsic semiconductors – *n*-type and *p*-type semiconductors (Qualitative) – Hall effect – Determination of Hall voltage (Theory and experiment) – Applications of Hall effect. **Practical component:** Current – Voltage (IV) characteristics of semiconductor diode	**BTL3**
MODULE 5: MODERN OPTICS	**(9L + 6P)**
Principles of laser – Stimulated absorption – Spontaneous emission – Stimulated emission – Population inversion – Pumping action – Active medium – Laser characteristics – Nd-YAG laser – CO_2 laser – Dye laser – Laser in Industrial applications. Optical fiber – Principle and propagation of light in optical fibers – Numerical aperture and acceptance angle – Types of optical fibers – Optical fiber as temperature sensors. **Practical component:** Laser – Determination of the wave length of the laser using grating Laser – Particle size determination using lycopodium powder	**CO5** **BTL3**

TEXT BOOKS	
1	Rajendran V. (2017), *Engineering Physics*, Tata McGraw Hill Publications, 3rd Edition, US.
2	Gaur R. K. and Gupta S.L. (2014). *Engineering Physics*, 8th edition, DhanpatRai publications (P) Ltd., New Delhi
3	Mani P. (2016),*Engineering Physics*,Dhanam Publications, 13th Edition, Chennai.
REFERENCE BOOKS	
1.	Arthur Beiser (2017),*Concepts of Modern Physics*, Tata McGraw Hill Publications, 7th Edition, US.
2.	Halliday, Resnick and Walker (2021), *Fundamental of Physics Extended*, Wiley & Sons, 12th Edition, US.
3	Shaikh I. A,Kulkarni H. R,Mohril, S. F. andKhairnar(2018), *Engineering Physics*, NiraliPrakashanPublishers, 5thEdition, Pune.
E BOOKS	
1.	https://industri.fatek.unpatti.ac.id/wp-content/uploads/2019/03/042-Fundamentals-of-Physics-II-Electromagnetism-Optics-and-Quantum-Mechanics-R.-Shankar-Edisi-1-2016.pdf
2.	https://zenodo.org/record/243407#.Y0EfilxBzIU
3.	https://salmanisaleh.files.wordpress.com/2019/02/physics-for-scientists-7th-ed.pdf
MOOC	
1.	http://nptel.ac.in/courses/115106061
2.	http://nptel.ac.in/courses/117101054/12

COURSE TITLE	**PROGRAMMING IN PYTHON**			**CREDITS**	**4**
COURSE CODE	**ECS51002**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-2-1**

Version	1.0	Approval Details	23 ACM, 06.02.2021	LEARNING LEVEL	BTL- 5
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project / Practical**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**20%**	**--**	**--**	**50%**
Course Description	Computer programming skills are now becoming part of basic education as these skills are increasingly of vital importance for future job and career prospects. The Python programming language which is one of the most popular programming languages worldwide. The course shows how to use the free open-source Python to write basic programs and high level applications. This course is offered as a Theory Integrated Practical course by practicing Project Based Learning (PBL), emphasizing learning by doing, where the objective is to provide the students with the required hands-on exercises / projects that complements the theoretical understanding of the subject matters. The assessment is through the combination of written tests as well as practical through projects.				
Course Objective	The course should enable the students to 1. To introduce basic concepts of Python programming language as well as common packages and libraries. 2. To generate an ability to design, analyze and perform experiments on real life problems in mechatronics engineering using python.				
Course Outcome	Upon completion of this course, the students will be able to 1. Comprehend basic concepts in python. 2. Write python program to solve scientific, mathematical problems 3. Develop modular programs using functions and use data structures 4. Use toolboxes/ libraries and design simple algorithms using Python to solve real time applications				
Prerequisites:					

CO, PO AND PSO MAPPING

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

CO – 5	1	1	1	1	1	-	-	2	-	-	2	1	2	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PYTHON FUNDAMENTALS	**(9L+ 6P=15)**
Introduction to python and its applications. Installation of Python and setting up a programming environment such as Anaconda and Spyder Python Basics: Variable and variable types, Booleans, Numbers: integers, floats, fractions, complex numbers, basic operators (arithmetic, relational, logical, membership, identity) **Practical component:** 1. Solve simple mathematical expressions using python 2. Perform type conversion **Suggested Readings:** 1. 10 Reasons to Learn Python Programming Language in 2022 2. Learning Python: From Zero to Hero	**CO-1** **BTL-3**
MODULE 2: STRINGS, LISTS, TUPLES	**(9L+ 6P=15)**
Strings, lists, tuples, sets, dictionaries. bytes and byte arrays, Manipulating variables, indexing, slicing, String methods, list methods, list slicing, set methods, in built python functions, input and output functions. **Practical component:** 1.Perform string manipulation2.Data sorting using lists3.Write functions for data handling **Suggested Readings:** 1. Python programming for beginners	**CO-2** **BTL-5**
MODULE 3: CONTROL STATEMENTS, LOOP AND FILE HANDLING	**(9L+ 6P=15)**
If, else, else if statements, for loops, range function, while loops, List comprehensions, functions in python. Introduction to OOP, Classes, Objects, Reading and writing files **Practical component:** 1. Write a python program using control statements 2. Develop objects and classes in python 3. Work with files for specific applications **Suggested Readings:** 1.Python programming for beginners	**CO-3** **BTL-5**
MODULE 4: PYTHON LIBRARIES	**(9L+ 6P=15)**
Installing of different libraries, packages or modules. Basic concepts of the following libraries: NumPy, Matplotlib, Pandas, SciPy libraries **Practical component:** 1.Python programming using libraries **Suggested Readings:**	**CO-4** **BTL-5**

1. The Python Bible	
MODULE 5: CASE STUDIES	**(9L+ 6P=15)**
Case Studies using Python 1. Solving a linear differential equation using SciKit and plotting the result in matplotlib. 2. Image processing and manipulation and auto detection of any object based on color. 3. Python programming for an Arduino/ Raspberry PI 4. Machine Learning application using python 5. Case study that uses Python to solve department specific problems. **Practical component:**1.Mini Project / Case studies **Suggested Readings:**1.Python at Netflix	**CO-5** **BTL- 5**

TEXTBOOKS	
1.	Dr. R. NageswaraRao (2018). *Core Python Programming*, Dreamtech Press, Second Edition
2.	M.T. Savaliya and R.K.Maurya (2018). Programming through Python, StarEdu Solutions
REFERENCE BOOKS	
1.	Python Crash Course: A Hands-On, Project-Based Introduction to Programming (2nd Edition)
2.	Head-First Python: A Brain-Friendly Guide (2nd Edition)
E BOOKS	
1.	https://devfreebooks.github.io/python/
2.	"The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
E BOOKS	
1.	https://devfreebooks.github.io/python/
2.	"The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/

COURSE TITLE	**ENGINEERING GRAPHICS AND COMPUTER AIDED DESIGN (Aero, Auto, Civil, Bio-Tech, Mechanical)**			**CREDITS**	**3**
COURSE CODE	**EME51001**	**COURSE CATEGORY**	**ES**	**L-T-P-S**	**2-0-2-1**
Version	**1.0**	**Approval Details**		**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment (Theory + Practical)	**Second Periodical Assessment (Theory + Practical)**	**Weekly assignment/Observation / lab records and viva as approved by the**	**Surprise Test/ Quiz etc., as approved by the DEC**	**Attendance**	**ESE (Theory + Practical)**

		DEC			
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course broadly introduces the mechanical design using computer aided design tools and fundamentals of free hand sketching. It prepares the students to learn the basic concepts involved in technical drawing and computer graphics. It also emphasis on the principles of projections and visualization of part drawing.
Course Objective	1. To demonstrate the concepts of Engineering graphics and projection of straight lines using CAD software 2. To visualize the solids in various orientations and to draw its projections 3. To comprehend the concepts of isometric projections 4. To draw the development of solid surfaces and to generate associated views of civil drawings. 5. To visualize and draw views of the object by free hand sketch and to transform 3D models to 2D drawings using CAD tools
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the concepts of Engineering graphics and projection of straight lines using CAD software. 2. Apply the acquired knowledge to solve simple problems of regular solids. 3. Create solid objects in isometric view using CAD software 4. Develop the simple solids and to sketch the plan and elevation of the building drawings 5. Visualize the objects and to draw by free hand sketching.

Prerequisites: Nil

CO, PO AND PSO MAPPING

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

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF ENGINEERING GRAPHICS	**(6L + 6P =12)**
Relevance of Graphics in Industry - BIS conventions and specifications - drawing sheet sizes - Lettering – Dimensioning - Scales. Drafting methods - Introduction to Computer Aided Drafting –Exposure to Solid Modelling software – Printer and Plotter – 3D printer. Introduction to Orthographic projections - Naming views as per BIS - First angle projection method. Projection of points and projection of Straight lines. ***Suggested Reading:*** *Solid modelling Software commands*	**CO-1** **BTL-2**
MODULE 2: PROJECTION OF SOLIDS	**(6L + 6P =12)**

Projections of solids. Solids in simple positions and axis inclined to one plane only. Section of solids. Section planes inclined to Horizontal Plane only. True shape of the section. (Manual and CAD Drawing) ***Suggested Reading:*** *Solids inclined to both the planes. Section of solids with sectional planes inclined to VP.*	**CO-2** **BTL-2**
MODULE 3: ISOMETRIC PROJECTION	**(6L + 6P =12)**
Concepts of isometric projection. Isometric scale, Isometric view of simple solids with sectional planes. (Manual and CAD Drawing) ***Suggested Reading:***Isometric view of solids with multiple sectional planes.	**CO-3** **BTL-3**
MODULE 4: DEVELOPMENT OF SURFACES AND CIVIL DRAWING	**(6L + 6P =12)**
Development of Surfaces of simple solids with simple sectional planes. Parallel line method and Radial line method only. (Manual and CAD Drawing) Civil Drawing: PLAN and ELEVATION of Simple residential building. (Manual and CAD Drawing) ***Suggested Reading:*** *D*evelopment *of S*phere, *Sectional elevation of building drawing*	**CO-4** **BTL-2**
MODULE 5:FREE HAND SKETCHING	**(6L + 6P =12)**
Visualization concepts and Free Hand sketching: Visualization principles — Representation of Three Dimensional objects — Pictorial Projection methods - Layout of views- Conversion of pictorial views to orthographic view. ***Suggested Reading:****Orthographic views to pictorial views*	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Jeyapoovan, T., Engineering Graphics and Design, Vikas Publishing House Pvt Ltd., New Delhi, 8th Edition, 2022.
2.	P. Kannaiah, K. L. Narayana, K. Venkata Reddy, A Textbook on Engineering Drawing, BS Pub, 2016.
REFERENCE BOOKS	
1.	Alf Yarwood, Introduction to AutoCAD – 2D and 3D Design, Newnes Elsevier, 2011
2.	Bhatt N.D and Panchal V.M, Engineering Drawing: Plane and Solid Geometry, Charotar Publishing House, 2019.
3.	KirstiePlantenberg, Engineering Graphics Essentials, SDC Publications., fifth Edition, 2016.
E – Books	
1.	https://www.amazon.in/Technical-Drawing-Engineering-Graphics-International-ebook/dp/B00IZ0FZHA
MOOC	
1.	http://nptel.ac.in/courses/112103019/
2.	https://nptel.ac.in/courses/112102304/

COURSE TITLE	**PERSONALITY DEVELOPMENT & SOFT SKILLS**	**CREDITS**	**2**

COURSE CODE		ELS51002	COURSE CATEGORY	HS	L-T-P-S	1-0-2-1
Version	1.0	Approval Details	35th ACM - 6th Aug. 2022		LEARNING LEVEL	BTL – 4

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Weekly assignment/ lab record and viva as approved by the Department Examination Committee "DEC"	Surprise Test / Quiz., as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (ESE) Theory + Practical
15 %	15%	10 %	5 %	5 %	50%

Course Description	This course teaches the learners LSRW Skills which is needed in today's global workplace together with essential business vocabulary & grammar. It equips them to communicate effectively and at professional and social scenario which in turn makes them confident individuals. This course would help them to appear for Cambridge Certification and add value to their profile and validate their language proficiency.
Course Objective	1. To acquire self-confidence by which the learner can improve upon their informative listening skills by an enhanced acquisition of the English language. 2. To provide an environment to Speak in English at the formal and informal levels and use it for daily conversation, presentation, group discussion and debate. 3. To equip the students to Read, comprehend and answer questions based on literary, scientific and technological texts. 4. To enhance the writing skills of the students via training in instructions, recommendations, checklists, process-description, letter-writing and report writing. 5. To equip the learners in analyzing and applying creative thinking skills and participate in brainstorming, mind-mapping, audiovisual activities and excel in employability skills.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the ability to construct the grammatically correct sentences with accuracy and syntax structures. 2. Integrating various components of English Language and determining it through reading and listening. 3. Analyze and transcode data, construct different types of written essays, read complex passages and summarize ideas, create personal profiles in the form of a resume. 4. Organize and articulate ideas, concepts, and perceptions in a comprehensive manner in written business correspondence, and speaking in formal and informal situations. 5. Infer details about presentation skills and implementing it in various professional situations.

Prerequisites: Plus Two English-Intermediate Level

CO, PO AND PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	-	-	-	-	-	-	-	-	-	3	-	-	To be marked by respective department		
CO2	-	-	-	-	-	-	-	2	2	3	-	-			
CO3	-	-	-	-	-	-	-	-	-	3	-	-			
CO4	-	-	-	-	-	-	2	-	-	3	2	-			
CO5	-	-	-	-	-	-	-	-	2	3	2	3			

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1 : ATTITUDE	**(3L+6P = 9)**
Grammar : 1. Countable and uncountable nouns 2. Asking questions 3. Expressing likes 4. Introducing reasons 4. Talking about large and small differences. 5. Expressing Results **Vocabulary:** 1. Recruitment Brochure: ability, certificate, course, etc., 2. Work, job, training course. 3. Job Responsibilities 4. Staff, Employee, member of Staff. 5. Phrases expressing enthusiasm 6. Adjective Forms **Writing :** 1. Report Writing – Staff Training Report 2. A Website entry 3. A short Email and an Email of a job application. **Reading :** Articles on Human Resources **Soft Skills And Employability Skills (LAB): ATTITUDE:** The power of positive thinking – Positive self - talk – self-esteem and positive attitude who Am I? Attitude in the workplace – Building a positive attitude – Testing your attitude – Adaptability	**CO-1** **BTL-2**
MODULE 2 : GOAL SETTING	**(3L+6P = 9)**
Grammar: 1.Infinitive or verb + ing, 2. Prepositions in phrases describing trends 3. Formal requests 4. First and Second conditionals. 5. Phrases followed by a Verb + ing. **Vocabulary:** 1. Word related to marketing (Launch, Play, Find out, Learn, Know, etc.,) 2. Revenue outcome 3. Adjective – noun collocations, 3. Last and latest **Writing:** 1. A marketing Report2. Email giving information – making an enquiry – answering enquiries – correcting information – confirming terms 3 Memo Writing **Reading :** Articles on Marketing **Soft Skills And Employability Skills (LAB): GOAL SETTING:** What is goal? - What are SMART goals? - How does SMART goal setting work? - Goals as commitment – Useful Guideline for goal setting – Trying personal and professional goals – Goals at the workplace – Cascading goals – Types of goals	**CO-2** **BTL-3**
MODULE 3 : TIME MANAGEMENT	**(3L+6P = 9)**
Grammar: 1. Prepositions in time phrases 2. Making recommendations 3. Phrases signaling parts of a presentation 4. Can and could **Vocabulary:**1. Financial Terms 2. Rising finance 3. Noun Phrases connected with starting companies 4. Assets, collateral etc., **Writing:** Formal Letter: 1. A letter of enquiry2. Proposal Writing **Reading :**Articles on Entrepreneurship **Soft Skills And Employability Skills (LAB): TIME MANAGEMENT**: What is time management? Prioritization – Time stressors – Time stealers – Time management - Eisenhower Matrix– Strategies for effective time management – productivity pyramid – The four Ds of time management	**CO-3** **BTL-3**
MODULE 4 : EMOTIONAL INTELLIGENCE	**(3L + 6P = 9)**

Grammar: 1. Referencing 2. Using the Passives to express opinions and ideas. 3. Relative Clauses **Vocabulary:** 1. Collocations describing reasons for meetings, 2. Collocations with meeting 3. Crucial, priceless, etc., **Writing:** Arranging to travel; an email agreeing to a request and making suggestions – giving instructions – about a business trip – announcing a job opportunity. 2. A letter informing about a new service – complaint, **Reading :** Articles on Business abroad **Soft Skills And Employability Skills (LAB): EMOTIONAL INTELLIGENCE:** What is Emotional Intelligence? Enhancing your emotional self-awareness, - Emotional intelligence and change management – unfreezing the old, re-freezing the new – change and stress – emotional intelligence and crisis management.	**CO-4** **BTL-3**
MODULE 5 : LEADERSHIP	**(3L + 6P = 9)**
Grammar: 1. Using the Definite Article 2. Expressing Causes 3. Reporting verbs and reported speech 4 Third Conditional(Imaginary) **Vocabulary**1. Verb – Noun collocations 2. Issues, impact, etc., 3. Way or method 4. Words and phrases expressing numbers. **Writing**: Mail arranging a meeting, introducing a company and asking for information – giving suggestions 2. A memo asking for suggestions 3. A proposal for out sourcing. **Reading :** Articles on Change in Business **Soft Skills And Employability Skills (LAB): LEADERSHIP :** Qualities of a leader – Leadership and assertiveness – problem –solving and decision-making – Approaches to problem – solving and decision-making – Brainstorming – Cause-and-effect analysis	**CO-5** **BTL-4**

TEXT BOOKS	
1	Brook-Hart, Guy (2019). Cambridge English Business Benchmark, Upper Intermediate. Cambridge University Press. India (Pages 208)
2.	Pillai, Sabina. Fernandez, Agna.(2018). Soft Skills And Employability Skills. Cambridge University Press. India. (Pages 208)
REFERENCE BOOKS	
1.	Murphy, Raymond(2019). Intermediate English Grammar. Cambridge University Press. India. (Pages 350)
2.	Barnes, D., (2020). Exploratory talk for learning in Mercer, N. and Hodgkinson, S. (eds) Exploring Talk in School. London: Sage Publications. (Pages 208)
3.	Dhanavel. S P (2018). English and Soft Skills. Orient BlackSwan. India. (Pages 136)
4.	Goldsmith, Marshall & M.S. Rao.(2020) Soft Skills: Enhancing Employability. Dreamtech Press. India (Pages 256)
E Books	
1	https://www.pdfdrive.com/basic-english-grammar-with-exercises-e12486779.html
2	http://dspace.vnbrims.org:13000/jspui/bitstream/123456789/4733/1/Leadership%20The%20Power%20of%20Emotional%20Intellegence.pdf
MOOC Courses	
1	https://www.edx.org/professional-certificate/ritx-communication-skills
2	https://www.coursera.org/specializations/people-and-soft-skills-for-professional-success

COURSE	**FAB LAB FOR CHEMICAL ENGINEERS**	**CREDITS**	**2**

TITLE					
COURSE CODE	ECH51400	COURSE CATEGORY	ES	L-T-P-S	0-1-2-2
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Weekly assignment /Observation / lab records as approved by DEC	Surprise Test / Quiz as approved by DEC	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The FAB Lab helps students to learn the basic laboratory skills in fabricating and designing equipment like Reactors, heat exchangers, fuel cell and pollution control.
Course Objective	1. To organize good and safe laboratory practices in handling reactors. 2. To solve design concepts of heat exchangers. 3. To sketch fuel cells for energy production. 4. To choose proper methods to control the pollution of air, soil and noise. 5. To demonstrate treatment technology in wastewater treatment.
Course Outcome	After successful completion, the student will be able to 1. Explain reactor analysis and designing reactors in the laboratory. 2. Organize design concepts and fabrication of a heat exchanger. 3. Demonstrate the configuration of fuel cell. 4. Apply the techniques to mitigate to pollution in air, soil and noise. 5. Sketch the methods for controlling pollution in water.

Prerequisites: NIL

CO, PO AND PSO MAPPING

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

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1:REACTORS	**(3L+6P)**
Types of reactors, Design configuration of reactors – Materials of Construction – Reaction studies, Industrial applications **Lab component:** Fabrication of Batch reactor	**CO-1** **BTL-3**
MODULE 2:HEAT EXCHANGERS	**(3L+6P)**
Types – principle and working of heat exchanger, Types of heat exchanger – double pipe heat exchanger, Shell and Tube heat exchanger – Advantages and disadvantages – Flow arrangement, Industrial application **Lab component:** Fabrication of Double pipe heat exchanger.	**CO-2** **BTL-3**
MODULE 3:FUEL CELLS	**(3L+6P)**
Principle and working of Fuel cells – Types – Configuration – Material of Construction – Industrial applications **Lab component:** Fabrication of fuel cells for energy production.	**CO-3** **BTL-3**
MODULE 4:ENVIRONMMENTAL POLLUTION CONTROL	**(3L+6P)**
Types of Pollution – Air, Noise, land - Methods of pollution abatement, Standards – National, International. **Lab component**: Fabrication of Bio digester, Treatment of Leachate.	**CO-4** **BTL-3**
MODULE 5:WASTEWATER TREATMENT	**(3L+6P)**
Wastewater characteristics – COD, BOD, Ph, turbidity, Hardness, TSC, TDS, Types of waste water treatment – Physical, Chemical and Biological, STP, ETP, Wetland – vertical , horizontal. **Lab components:** Fabrication of Wet land, Determination of waste water parameters.	**CO-5** **BTL-3**
TEXT BOOKS	

1	Gavin Towler, Ray Sinnott. (2012). *Chemical Engineering Design – principles, practice and economics of plant and process design,* Elsevier Publishers, 2 nd Edition.
2.	J. Jeffrey Peirce, P. Aarne Vesilind, Ruth F. Weiner (1997) *Environmental Pollution and Control*, Elsevier, 4th edition.
3.	Supramaniam Srinivasan. (2006). *Fuel cells from fundamentals to application*, Springer Publishers,1 st edition
REFERENCE BOOKS	
1.	Mahajani (2009). *Process equipment design*, Macmillan publishers, 4th edition
2.	Narayanan P.(2009). *Environmental Pollution: Principles, Analysis and Control*, CBS Publishers, I st Edition.
3.	Ryan O'Hayre., Suk-Won Cha., Whitney G. Colella., Fritz B. Prinz. (2016).*Fuel cell fundamentals*, John Wiley & Sons, New Jersey, 3 rd Edition
E BOOKS	
1.	https://idcwebstorage1.blob.core.windows.net/pdc-identicard knowledgebase/EPI%20Suite/EPI_Suite_User_Guide.pdf
MOOC	
1. 2. 3.	**https://nptel.ac.in/courses/103107143** **https://onlinecourses.nptel.ac.in/noc22_ch45/preview** **https://nptel.ac.in/courses/103102015**

COURSE TITLE	**DESIGN THINKING FOR CHEMICAL ENGINEERS**			**CREDITS**	**2**
COURSE CODE	**ECH51402**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-1-2-1**
Version	**1.0**	**Approval Details**		**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Weekly assignment/Observation / lab records as approved by DEC**	**Surprise Test / Quiz as approved by DEC**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course will offer an immersive experience in Design Thinking as a tool for innovative idea generation and application in product development.				

Course Objective	1. To organize insights into design thinking concepts and principles 2. To apply design thinking methods in every stage of the problem 3. To demonstrate the different phases of design thinking 4. To apply various methods in design thinking to develop prototypes 5. To categorize the steps involved in transferring a process/product to industry
Course Outcome	Upon completion of this course, the students will be able to 1. Explain the key concepts of design thinking 2. sketch the stages of design thinking for problem solving 3. Organize design thinking strategy to product/process development 4. Prepare a prototype of the process/product and marketing strategies 5. Demonstrate the prototype for industrial application

Prerequisites: NIL

CO, PO AND PSO MAPPING

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

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:PRINCIPLES OF DESIGN THINKING	**(3L+6P)**
Design thinking in General: The Concept of Design Thinking, The Principles and the mindset of Design Thinking, Generic Phases of Design Thinking process and activities involved in each of the phase, Design Thinking Frameworks. **Lab Component**: An exercise to read and present a new design thinking ability.	**CO-1** **BTL-3**
MODULE 2:PROBLEM IDENTIFICATION IN DESIGN THINKING	**(3L+6P)**
Empathize - Goals and methods, Usage of Tools (Design Briefs - Nine Criteria with example), Creation of Personas, Illustrative application of Personas). Importance of Define Phase, activities, Tools - Experience Mapping process with example, Developing Insights using HMW Questions, question ladder. **Lab Component**: An exercise will be performed on empathize and define phase of design thinking	**CO-2** **BTL-3**
MODULE 3:PROBLEM SOLVING PROCESS IN DESIGN THINKING	**(3L+6P)**
Importance of Ideate Phase, 77 Design Heurisitics, Diverge Ideas, and Converge Ideas A Design Thinking Product Development Framework", Prototype to product. **Lab Component**: An exercise to choose a case study and implementation of all phases will be performed	**CO-3** **BTL-3**
MODULE 4:MARKETING THE DESIGNED PROCESS/PRODUCT	**(3L+6P)**

Design for "X"; covering quality, reliability, safety, manufacturing/construction, assembly, maintenance, logistics, handling; disassembly; recycling; re-engineering . Packaging; shipping; marketing; feed-back on design. **Lab Component**: An exercise to promote and market the product/process developed (Marketing strategies to promote eco friendly products).	**CO-4** **BTL-3**
MODULE 5:DESIGN IMPLEMENTATION	**(3L+6P)**
Product centered and user centered design. Value engineering, Concurrent engineering, Reverse engineering in design; Design as a marketing tool; Intellectual Property rights - Trade secret; patent; copy-right; trademarks; product liability. **Lab Component**: An exercise to articulate the developed process as a proposal to implement in an industry	**CO-5** **BTL-3**
TEXT BOOKS	
1.	Gavin Ambrose and Paul Harris. (2010). *Basics Design 08: Design Thinking*, AVA Publishing SA
2.	Vijay Kumar. (2013). 101 Design Methods: *A Structured Approach for Driving Innovation in Your Organization*, John Wiley and Sons Inc, New Jersey
3.	Müller – Roterberg., Christian. (2018). *Handbook of Design Thinking*. Kindle Direct Publishing, 1 st Edition.
REFERENCE BOOKS	
1.	Roger L. Martin. (2018). *Design of Business: Why Design Thinking is the Next Competitive Advantage*, 2009, Harvard Business Press, Boston MA 2 nd edition
2.	BP Banerjee . (2005). *Foundations of Ethics and Management*, Excel Books, 1 ST Edition.
3.	Maurício Vianna., Ysmar Vianna., Isabel K. Adler., Brenda Lucena., Beatriz Russo. (2011). *Design thinking: business innovation*, MVJ Press, 1 ST Edition.
E BOOKS	
1	http://ajjuliani.com/design-thinking-activities/5.https://venturewell.org/class-exercises
MOOC	
1. 2.	https://www.coursera.org/learn/uva-darden-design-thinking-innovation https://onlinecourses.nptel.ac.in/noc22_mg32/preview

SEMESTER – II

COURSE TITLE	**ANALYTICAL MATHEMATICS (Common to ALL B. Tech)**			**CREDITS**	**4**
COURSE CODE	**EMA51002**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**3-0-2-1**
Version	**1.0**	**Approval Details**		**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					

CIA					ESE	
First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Practical Assessments	Observation / Lab records as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (Theory)	End Semester Examination (Practical)
15%	**15%**	**10%**	**5%**	**5%**	**25%**	**25%**

Course Description	**To make the student understand the basic analytical mathematical skills that is imperative for effective understanding of engineering subject using MATLAB.**
Course Objective	1. To implement problem solving skills using vectors 2. To provide an exposure on the concepts of complex variables, conformal mapping and Bilinear transformation. 3. To comprehend integrals using Cauchy's integral and residue theorem. 4. To illustrate the applications of Laplace Transforms 5. To make the students understand the concept of Fourier series
Course Outcome	Upon completion of this course, the students will be able to 1. Verify the standard theorems in Vector Calculus and apply them to evaluate surface area and volume. 2. Construct an analytic function when real and imaginary parts are given. 3. Evaluate finite integrals using Cauchy's theorem. 4. Solve the system of ordinary differential equations using Laplace Transform 5. Expand the Fourier series for the given function.

Prerequisites: Knowledge insingle-variable calculus.

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2	PSO-3
CO -1	3	3	2	-	1	-	-	-	-	-	-	1	To be marked by respective department		
CO -2	3	2	1	-	2	-	-	-	-	-	-	1			
CO -3	3	2	1	2	1	-	-	-	-	-	-	1			
CO -4	3	3	2	1	1	-	-	-	-	-	-	2			
CO -5	3	3	2	-	1	-	-	-	-	-	-	2			

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1:VECTOR CALCULUS	**(9L+6P)**
Gradient, Divergence and Curl – Unit normal vector, Directional derivative – angle between surfaces- Irrotational and Solenoidal vector fields. Green's theorem - Gauss divergence theorem and Stoke's theorem (without proof) – Verification and evaluation of the above theorems - Simple applications to regions such as square, rectangle, triangle, cuboids and rectangular parallelopipeds. Suggested Reading: Basics of Vectors **Lab: Gradient, Divergence, Curl, Irrotational and Solenoidal vector fields**	**CO-1** **BTL-3**
MODULE 2: COMPLEX VARIABLES	**(9L+6P)**
Functions of a complex variable – Analytic function - Cauchy - Riemann equations – Properties of analytic function (Statement Only) – Construction of Analytic functions by Milne – Thomson method – Conformal Mapping – Mapping by functions $w = z + c, w = cz, w = 1/z$, Bilinear transformation. Suggested Reading: Complex Numbers **Lab: Verification of Analytic Function**	**CO-2** **BTL-3**
MODULE 3: COMPLEX INTEGRATION	**(9L+6P)**
Statement and Application of Cauchy's Integral theorem and integral formula (without proof)-Evaluation of integrals using the above theorem-Taylor and Laurent series expansions-Singularities-Classification. Residues-Cauchy's residue theorem (without proof)-Contour integration over unit circle and semicircular contours (excluding poles on boundaries) Suggested Reading: Types of integration **Lab: Evaluation of integrals using Cauchy's Integral formula and Cauchy's residue theorem.**	**CO-3** **BTL-3**
MODULE 4:LAPLACE TRANSFORMS	**(9L+6P)**
Laplace transform – Conditions of existence – Transform of elementary functions – properties – Transforms of derivatives – Initial and final value theorems – Transform of periodic functions. Inverse Laplace transforms using partial fraction and convolution theorem. Solution of linear ODE of second order with constant coefficients. Suggested Reading: Basics of Transform **Lab: Solutions of differential equations using Laplace transform**	**CO-4** **BTL-3**
MODULE 5: FOURIER SERIES	**(9L+6P)**
Dirichlet's Conditions – General Fourier Series – Odd and even functions – Half range sine and cosine series –Harmonic Analysis. Suggested Reading: Basics of series **Lab: Finding Fourier Series**	**CO-5** **BTL-3**
TEXT BOOKS	

1.	A. Chandrasekaran, G. Kavitha (2022), *Analytical Mathematics*, Dhanam Publications, 1st Edition, Chennai.
2.	T. Veerarajan (2016), *Engineering Mathematics-II*, McGraw Hill Education (India), Private Limited, 4th Edition, New Delhi.
3.	Raj Kumar Bansal, Ashok Kumar Goel, Manoj Kumar Sharma (2016), *MATLAB and its Applications in Engineering*, Pearson Publication, 2nd Edition, New Delhi.
4.	D. G. Duffy (2021), *Advanced Engineering Mathematics With MATLAB (Advances in Applied Mathematics)*, Chapman and Hall Publisher, 5th Edition, CRC Press, USA.
REFERENCE BOOKS	
1.	P. Sivarama Krishna Das, C. Vijayakumari (2017), *Engineering Mathematics*, 1st Edition, Pearson Publishing, Chennai.
2.	A. P. Santhakumaran, P. Titus P (2017), *Engineering Mathematics – II*, NiMeric Publications, 2nd Edition, Nagercoil, India.
3.	Kreyszig Erwin (2016) *Advanced Engineering Mathematics*, John Wiley and Sons, 10th Edition, New Delhi.
4.	S.S. Sastry (2015), *Engineering Mathematics*, Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi.
E BOOKS	
1. 2. 3. 4.	http://ggn.dronacharya.info/APSDept/Downloads/QuestionBank/Mathematics-I/SectionD.pdf. https://people.math.sc.edu/girardi/m7034/book/AshComplexVariablesWithHyperlinks.pdf https://ocw.mit.edu/courses/18-03sc-differential-equations-fall-2011/pages/unit-iii-fourier-series-and-laplace-transform/ https://www.pdfdrive.com/calculus-ii-sequences-and-series-e11676778.html
MOOC	
1.	https://www.edx.org/course/introduction-engineering-mathematics-utarlingtonx-engr3-0x

COURSE TITLE	**ENGINEERING MATERIALS (Common to ALL B.Tech.)**			**CREDITS**	**4**
COURSE CODE	**ECT51001**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**3-0-2-2**
Version	**1.0**	**Approval Details**		**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment (Theory)	**Second Periodical Assessment (Theory)**	**Practical Assessments**	**Observation / lab records as approved by the Department Examination Committee "DEC"**	**Attendance**	**ESE**

15%	**15%**	**10%**	**5%**	**5%**	**Theory 25%** **Practical 25%**

Course Description	**To expose the students to the basics of Engineering Materials and their applications.**
Course Objective	1. To make the students understand the basics of crystal structure and phase rule. 2. To provide a knowledge on the theoretical basis of the chemical composition, properties and applications of abrasives, adhesives, lubricants and refractories. 3. To give a strong foundation on the basic concepts of nanomaterials, the general synthetic methods with emphasis on their applications. 4. To provide an exposure on the fundamentals and applications of polymeric materials and composites. 5. To illustrate the applications of energy materials, liquid crystals and conducting polymerswith a good exposure on their basic terminologies.
Course Outcome	Upon completion of this course, the students will be able to 1. Propose and justify suitable metals/materials for alloying. 2. Distinguish and select a suitable material as abrasives / adhesives / lubricants / refractories based on its properties and applications. 3. Select an appropriate technique for nanomaterial synthesis and characterization. 4. State and select a suitable polymeric / composite material for industrial applications. 5. Develop the suitable organic/inorganic materials that can be employed in energy storage / production and electronic devices.

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2	PSO-3
CO-1	**3**	**2**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**1**	**To be marked by respective department**		
CO-2	**3**	**2**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**			
CO-3	**3**	**2**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**			
CO-4	**3**	**2**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**			
CO-5	**3**	**2**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**2**			

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CRYSTAL STRUCTURE AND PHASE RULE (9L + 6P)

Basic crystal systems – Types, characteristics, examples – Space lattice, Unit cell – types – X-ray diffraction and crystal structure. Phase rule: Basic terminology - Derivation of Gibbs Phase rule- Phase diagrams: One component system (water), Two component system –- Reduced phase rule: Simple Eutectic system, examples, Phase diagram: Ag-Pb system, Pb-Sn system – Applications of phase rule. Practical component: Construction of phenol-water phase diagram - Determination of apparent density of porous solids.	**CO-1** **BTL-3**

MODULE 2: ABRASIVES, ADHESIVES, LUBRICANTS AND REFRACTORIES	(9L + 6P)
Abrasives – Classification, Properties, Uses –Adhesives – Development of Adhesive strength, Physical and Chemical factors influencing adhesive action, Classification of Adhesives – Epoxy Resin (Preparation, Properties and Applications) – Lubricants – Mechanism of Lubrication, Classification and Properties, Semi Solid Lubricants, Solid Lubricants, MoS_2 and Graphite - Refractories – Classification, Properties, Applications. Practical components: Preparation of urea-formaldehyde resin - Determination of porosity of a refractory	**CO-2** **BTL-3**
MODULE 3: NANOMATERIALS	**(9L + 6P)**
Introduction – Scope of nanomaterials - Types of nanomaterials - Synthesis of Nanomaterials - Bottom-up and Top-down approaches – Methods of preparation – Laser ablation, Sol-gel process, Gas-phase condensation, Chemical Vapour Deposition. Properties **–** Optical, Electrical, Magnetic, Chemical properties (introduction only). Characterization **–**UV-Visible spectroscopy, FE-SEM and TEM (Principle and Applications only). Practical component: Preparation of ZnO nanoparticles by wet chemical method – Verification of Beer-Lambert's law using silver nanoparticles.	**CO-3** **BTL-3**
MODULE 4: POLYMERS AND COMPOSITES	**(9L + 6P)**
Introduction – Basic definitions – Classification of polymers – Structure and property relationship of polymers – Plastics – Synthesis, properties and applications of polycarbonates and phenol-formaldehyde - Biodegradable Polymers, examples and applications. Composites - Introduction - Definition – Constituents – Classification - Fiber-reinforced Composites –Types and Applications. Practical components: Determination of molecular weight / viscosity of polymer using Ostwald Viscometer.	**CO-4** **BTL-3**
MODULE 5: MATERIALS FOR ENERGY AND ELECTRONIC APPLICATIONS	**(9L + 6P)**
Energy storage materials–Metal-hydride batteries, Li-batteries- Materials for solar cells: Semi-conductors - Materials for hydrogen technology - production (electrolysis), storage (hydrides), fuel cells. Liquid Crystals - Introduction –Characteristics – Optical properties-Classification –Chemical constitution and liquid crystalline behaviour - Applications. Conducting Polymers: Classification, Intrinsic Conducting Polymers, Extrinsic Conducting Polymers, Applications. Practical component: Preparation of polyaniline / Polypyrrole.	**CO-5** **BTL-3**

TEXT BOOKS

1.	Jain, P.C., Jain, M. (2018). *Engineering Chemistry*, Dhanpat Raj Publishing Company (P) Ltd, New Delhi, 17th Edition.
2.	Puri, B. R., Sharma, L. R., Pathania, M. S. (2020). *Principles of Physical Chemistry*, Vishal Publishing Co. Jalandhar, 47th Edition.
3.	Rangwala. (2017). *Engineering Materials*, Charotar Publishing House Pvt. Ltd, 43rd Edition.

RENCE BOOKS

1.	Clyne, T. W., Hull, D. (2019). *An introduction to composite materials*, Cambridge University Press, 3rd Edition.

2.	Shah,M. A., Ahmad,T. (2021). *Nano Science & Technology*, Dreamtech Press, 2021 Edition.
3.	Palanna,O. G. (2018). *Engineering Chemistry*, Mc Graw Hill Education (India) Pvt. Ltd, 2nd Edition.
E BOOKS	
1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
2.	https://abmpk.files.wordpress.com/2014/02/book_maretial-science-callister.pdf`
MOOC	
1.	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2.	https://www.mooc-list.com/tags/materials-science

COURSE TITLE	**INSTRUMENTAL ANALYSIS FOR ENGINEERS**			**CREDITS**	**4**
COURSE CODE	**ECH51001**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**2-1-2-1**
Version	**1.0**	**Approval Details**		**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment (Theory + Practical)	Second Periodical Assessment (Theory + Practical)	Weekly assignment/ Observation /lab records as approved by DEC	Surprise Test /Quiz as approved by DEC	Attendance	ESE (Theory + Practical)
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course provides a descriptive account on various types of instrumentation techniques and illustrate with examples, the interpretation of analytical data.
Course Objective	1. To identify different types of instrumental methods, Beer Lambert law and colorimetry 2. To understand principles, instrumentation and applications of molecular spectroscopy 3. To recognize the principles, instrumentation and applications of atomic spectroscopy, surface characterization techniques and principles of NMR, polarimetry and refractometry 4. To demonstrate various types of chromatographic techniques and their applications 5. To apply the principles and applications of electrochemical and thermos-analytical methods
Course Outcome	Upon completion of this course, the students will be able to 1. Identify the appropriate instrumental method of analysis based on the physical parameters and learn the fundamentals of spectroscopic approaches 2. Illustrate the data from vibrational, rotational characteristics of molecules 3. Prepare the spectroscopy at atomic level and gain knowledge on surface morphology 4. Demonstrate suitable chromatography techniques based on the nature of the substances present in a mixture and to make qualitative and quantitative assessment 5. Apply the basic knowledge gained on electrochemical analysis and analysis of thermo grams of various compounds and predict melting points

Prerequisites: Basic knowledge of chemistry at higher secondary level

CO, PO AND PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PS O1	PS O2	PSO3
CO-1	1	2	2	1	-	1	1	-	1	-	-	2	2	1	-
CO-2	1	2	1	1	2	-	1	-	-	-	1	2	-	1	2
CO-3	2	3	1	1	-	-	1	-	1	-	-	2	1	1	-
CO-4	3	2	1	1	-	1	1	2	-	-	-	2	-	1	-
CO-5	2	2	1	1	-	-	1	-	-	1	-	2	-	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO SPECTROSCOPY	**(6L+3T+6P)**
Classification of instrumental methods based on physical properties - Electromagnetic spectrum - Interaction of photons with matter – Beer-Lambert's Law: Absorbance, transmittance and their relationship, applications, limitations, Deviations – Photometric titrations, colorimetry - duboscqcolorimeter. **Lab Component:** Estimation of inorganic ions such as Fe, Ni using Beer-Lambert's Law, Estimation of dextrose by Colorimetry. **Suggested Reading:** Properties of light	**CO-1** **BTL-2**
MODULE2:MOLECULARSPECTROSCOPY	**(6L+3T+6P)**
Various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and Visible radiations, Chromophores, auxochromes, Bathochromic shift, hypsochromic shift, hyperchromic effect and hypochromic effect - Auxochromes and conjugation: Effects on the absorption maxima, Woodward-Fischer rules, UV, Visible and IR spectrophotometer: Instrumentation (Block diagram and various components) - Applications of UV & Visible and IR Spectroscopy: General, **Lab Component:** Determination of MnO_4^- by UV-Vis Spectrophotometry, Infrared Spectrometric Determination of Benzoic Acid and Salicylic Acid. **Suggested Reading:** Basics of carbon compounds and Transition metal complexes	**CO-2** **BTL-2**
MODULE 3: ATOMIC SPECTROSCOPY AND SURFACE CHARACTERIZATION	**(6L+3T+6P)**
Principle and functioning of Atomic Absorption Spectrophotometer (AAS), Atomic Emission Spectrophotometer (AES), Inductively Coupled Plasma - Optical Emission Spectrometry (ICP-OES), Atomic Fluorescence (AFS) - Instrumentation (Block diagram and various components): Atomic absorption and atomic emission spectrometry - Applications of AAS, AES, AFS – Principles and simple applications of Polarimetry, Refractometry, Nuclear Magnetic Resonance Spectroscopy, mass spectrometry, SEM, TEM and XRD. **Lab Component:**	**CO-3** **BTL-3**

Determination of sodium, potassium and calcium in drinking waters by flame photometry, estimation of a polymer concentration by refractometer, Determination of optically active substance using polarimetry. **Suggested Reading:** Crystal structures and Optical activity	
MODULE 4: CHROMATOGRAPHIC TECHNIQUES	**(6L+3T+6P)**
Chromatography: Classification –Principles, mode of separation, block diagram and Technique behind Column, Thin layer, Paper, Gas, High Performance Liquid Chromatography – Separation of organic compounds: By column and Thin layer chromatography –Paper chromatography: Separation of amino acids and separation of Cu, Co and Ni in a mixture – quantitative and qualitative estimation of organic compounds by GC and HPLC – Applications of ion exchange chromatography and size exclusion chromatography. **Lab Component:** Separation of amino acids by paper chromatography, Separation of sugars by thin layer chromatography, FAME analysis using GC. **Suggested Reading:** Principles of Chromatography.	**CO-4** **BTL-3**
MODULE 5: ELECTRODICS AND THERMOANALYTICAL METHODS	**(6L+3T+6P)**
Basics of ionic conductance, Electrode potential and pH - Principles behind potentiometry, conductometry and pH metry -Thermogravimetry: instrumentation, factors affecting the shapes of thermograms, applications, thermograms of some important compounds ($CuSO_4$, $5H_2O$, $CaC_2O_4.2H_2O$ etc.). Differential thermal analysis: Principle, instrumentation and applications, differences between DSC and DTA. Applications of DSC (Inorganic and Polymer samples). **Lab Component:** Analysis of water (pH, turbidity, conductivity, resistivity, suspended particles), Estimation of salinity of water, TGA analysis). **Suggested Reading:** Electrochemistry and Ionic equilibrium.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Petrozzi, S. (2012). *Practical instrumental analysis: methods, quality assurance, and laboratory management*. John Wiley & Sons.
REFERENCE BOOKS	
1.	Sharma, B.K. (2015). *Instrumental Methods of Analysis*. Goel publishing House, 7th Edition.
E BOOKS	
1.	https://pdfgoal.com/downloads/books_instrumental_methods_of_chemical_analysis_by_chatwal_pdf_pdf
2.	https://www.amazon.in/Instrumental-Method-Chemical-Analysis-Sharma/dp/8182836735
MOOC	
1.	http://riceonline.tendenciapp.com/mooc/course/analytical-chemistry- instrumentalanalysis/

COURSE TITLE	**UNIVERSAL HUMAN VALUES**			**CREDITS**	**2**
COURSE CODE	**EGE51001**	**COURSE CATEGORY**	**HS**	**L-T-P-S**	**2-0-0-1**

Version	1.0	Approval Details		LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course if mandatory as per the AICTE for the UG students to motivate the students for focusing on the human values. The main aim is to focus on the sustainability of happiness with harmony and natural acceptance in the career. Lecture cum power points are provided as guidelines from AICTE.				
Course Objective	1. To create awareness to students on themselves and their surroundings (family, society, nature). 2. To create responsibility among students on life in handling problems with sustainable solutions 3. To prepare the students with human relationships and human nature in mind. 4. To Prepare the students on critical ability and sensitive to their commitment.(human values, human relationship and human society). 5. To Apply the learning to their real life				
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the necessity of relationship with family, society and nature. Familiarize with the challenges ahead and proposed solutions. 2. Formulate and design human cyber security policies, plans and procedures for organizations. 3. Apply standard security countermeasure tools to sustain human relationships and nature.es. 4. Recognize the necessity of human values and relationship. 5. Demonstrate the learning in their real life.				

Prerequisites: CSB231 - Cryptography and Network Security

CO, PO AND PSO MAPPING

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

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Introduction **3L+6L=9**

Need, Basic Guidelines, Content and Process for Value Education Purpose and motivation for the course, recapitulation from Universal Human Values-I Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario Method to fulfil the above human aspirations: understanding and living in harmony at various levels. **Practical component:** Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co existence) rather than as arbitrariness in choice based on liking-disliking **Suggested Readings:** Evolution of cyber security	**CO-1** **BTL-2**
MODULE 2: Understanding Harmony in the Human Being	**(3L+6L=9)**
Harmony in Myself! Understanding human being as a co-existence of the sentient 'I' and the material 'Body' Understanding the needs of Self ('I') and 'Body' - happiness and physical facility Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) Understanding the characteristics and activities of 'I' and harmony in 'I' Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail Programs to ensure Sanyam and Health. **Practical component:** Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease	**CO-2** **BTL-2**
MODULE 3: Understanding Harmony in the Family and Society	**(3L+6L9)**
Harmony in Human-Human Relationship Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship Understanding the meaning of Trust; Difference between intention and competence Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals **Practical component:** Include practice sessions to reflect on relationships in family, hostel and institute	**CO-3** **BTL-3**

as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives	
MODULE 4: Understanding Harmony in the Nature and Existence	**(3L+6L=9)**
Whole existence as Coexistence - Understanding the harmony in the Nature - Interconnectedness and mutual fulfillment among the four orders of nature-recyclability and self regulation in nature -Understanding Existence as Co-existence of mutually interacting units in all-pervasive space -Holistic perception of harmony at all levels of existence. **Practical component:** Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.	**CO-4** **BTL-2**
MODULE 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics	**(3L+6L=9)**
Natural acceptance of human values, Definitiveness of Ethical Human Conduct Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order -Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. -Case studies of typical holistic technologies, management models and production systems-Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations. Sum up. **Practical component:** Include practice exercises and case studies to discuss the conduct as an engineer or scientist etc.	**CO-5** **BTL-2**

TEXT BOOKS

1. P.R Gaur, R Asthana, G.P Bagaria, Human Values and Professional Ethics (2nd revised edition) Excel Books, New Delhi, 2019
2. A Nagaraj, Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. A. N Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.

Lawrence, C. (2016). *Cyber security for Dummies*, John Wiley & Sons Inc., 2nd Edition, pp.213--432.

REFERENCE BOOKS

1.	AICTE STUDENT INDUCTION PROGRAM HANDBOOK - https://fdp-si.aicte-india.org/download/Guidelines/G012%20SIP%20Hand%20Book%20v2.pdf

E BOOKS

1.	https://fdp-si.aicte-india.org/download.php#1

COURSE TITLE	**Communication Skills**			**CREDITS**	**3**
COURSE CODE	**ELS51001**	**COURSE CATEGORY**	**HS**	**L - T – P – S**	**2 – 0 – 2 – 1**

Version	1.0	Approval Details	35th ACM - 6th Aug. 2022	LEARNING LEVEL	BTL 4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Weekly assignment/ lab record and viva as approved by the Department Examination Committee "DEC"	Surprise Test / Quiz., as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination (ESE) Theory + Practical
15 %	15%	10 %	5 %	5 %	50%

Course Description	The course has been designed to improve the communication competency of the students. The course builds on students' English language skills by engaging them in listening, speaking and grammar learning activities (LSRW) that are relevant to authentic contexts. This course trains the students how to communicate accurately, appropriately and fluently in professional and social situations. The course is framed so that the students can appear for Cambridge B1 Preliminary exams and also enable them to get a certification.
Course Objective	1. To acquire self-confidence by which the learner can improve upon their informative listening skills by an enhanced acquisition of the English language. 2. To provide an environment to Speak in English at the formal and informal levels and use it for daily conversation, presentation, group discussion and debate. 3. To equip the students to Read, comprehend and answer questions based on literary, scientific and technological texts. 4. To enhance the writing skills of the students via training in instructions, recommendations, checklists, process-description, letter-writing and report writing. 5. To equip the learners in analyzing and applying creative thinking skills and participate in brainstorming, mind-mapping, audiovisual activities and excel in employability skills.
Course Outcome	Upon completion of this course, the students will be able to 1. Acquire the accuracy through the knowledge of Syntax. 2. Demonstrate the skill of using the vocabulary and use it in sentences appropriately. 3. Infer texts and improvise its usage. 4. Illustrate language acquisition skills through formal correspondence. 5. Analyse and transcode the data and interpret it in text format.

Prerequisites: Plus Two English-Intermediate Level

CO AND PO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO3

CO1	-	-	-	-	-	-	-	-	-	**3**	-	**2**	**To be marked by respective department**
CO2	-	-	-	-	-	-	-	-	-	**3**	-	**2**	
CO3	-	-	-	-	-	-	-	**2**	-	**3**	-	**2**	
CO4	-	-	-	-	-	-	-	**2**	**2**	**3**	**2**	**2**	
CO5	-	-	-	-	-	-	-	-	-	**3**	**3**	**2**	

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1 : English for Employability	**(6L + 6P = 12)**
Grammar : 1. Parts of Speech – Identification and Transformation 2. Kinds of Sentences – Identification and Transformation 3. Sentence Pattern – Framing Sentences 4. Tenses – Rules & its usage – Present simple and present continuous; time expressions; state verbs – Past simple ; regular and irregular verbs and spelling of past simple forms ; past continuous. **Vocabulary :** 1. Job titles and describing jobs ; names of company departments 2. Computer terms; email and website terms. 3. Headings for CVs Describing application Procedures **Writing :** 1. Writing emails – formal and informal – phrases for emails & letters. 2. Writing a covering letter with a resume for a job application. **Reading :**Reading about Job and Company : 1. Changing places : job swapping at work. 2. The power of word of mouse : an article on the power of online customer options 3. Haier : an article about the history of a Chinese Company. 4. What kind of company Culture would suit you ?reading answering a quiz. **Lab Activities(Speaking) :** 1.Self Introduction. 2. Describing jobs ; asking other people about their jobs. 3. Asking about the history of a company ; past simple questions 4. Asking questions about companies and jobs. **Lab Activities(Listening) :** 1.Being a PA 2. Growing Pains : an interview with a business consultant about company's Growth. 3. Describing changes in a company : a Conversation on the phone.	**CO-1** **BTL-2**
MODULE 2 : English for Marketing	**(6L + 6P = 12)**
Grammar: 1. Concord - Understanding Subject Verb agreement – Identifying the error and Correcting 2. Active and Passive Voice – Identifying the voices and Transforming Active to passive and passive to active 3. Modal Verbs – Using to express modalities – in active and passive voices 4. Words to Describe causes and effects. 5. Prepositions **Vocabulary : 1.** Vocabulary to describe objects; component parts, shapes, dimensions, materials Describing problems with equipment 2. Verbs to Describe process 3. Vocabulary to talk about advertising and marketing, Language to describe cause and effect. **Writing :** 1. Topic Sentence 2. Paragraph Writing 3. Developing a story with the hints 4. Promotional letter(Email) **Reading :**Product Description and Advertisement : 1. Problems with equipment : emails and headings on a form. 2. Waratah : an article on an Australian clothing company. , Short Texts : Notices, Notes and messages 3. Selling your product abroad; an article , Workplace signs and notices 4. Descriptions of advertising media, Singapore airlines; an article on the branding of an airline. **Lab Activities(Speaking) :** 1.Role Play – Telephone call to a supplier, 2. Describing Objects **Lab Activities(Listening) :** 1. Describing dimensions of products : Conversations with colleagues and suppliers. – The Gizmo game : listening to the uses of a gadget. 2. Channel No.5 : an interview about a production process 3. Telephone conversations : information	**CO-2** **BTL-3**

about orders and deliveries. 4. Descriptions of how a product is advertised.	
MODULE 3 : Business Correspondence	**(6L + 6P = 12)**
Grammar :1. Tenses – Present continuous for future arrangements; will and going to future forms 2. Using discourse markers ; Sentence starters - Contrast & similarity words, 3. Degrees of Comparison – Framing sentences with appropriate adjectives and adverts – transformation from one degree to another degree. 4. Infinitives and gerunds – using infinitives and gerunds in sentences as different elements. 5. Conditionals – Three types of conditionals. **Vocabulary :**1.Vocabulary for travel 2. Synonyms and Antonyms 3. Employment Vocabulary **Writing :** 1. A letter(Email) of invitation – Accepting the invitation and declining the invitation. **Reading :**Transport, Working Holidays and Conferences : Travel Arrangements : notices and short messages : Eurostar : an article on train travel. 2. Netflix : an article about a company's holiday policy; thinking outside the box: an article on offsite meetings 3. Short Texts : Feedback on conferences **Lab Activities(Speaking) :** Discussion: How to make decisions **Lab Activities(Listening) :** 1. Making and changing appointments : Voicemail messages and phone conversations ; Future intentions and predictions : Short Extracts. 2. A travel Anecdote 3. Half Holidays: a conversations between two employees. 4. Discussing possible venues for a conference : a conversation between colleagues; a welcome speech at a conference.	**CO-3** **BTL-3**
MODULE 4 : English for Business Relationships	**(6L + 6P = 12)**
Grammar :1. Writing Instructions and Recommendations – Transforming instruction to recommendation and recommendation to instruction 2. Expressions of quantity – semi-negative words 3. Present Perfect : time expressions : present perfect versus Past simple. 4. Reported Speech – Direct and Indirect Speeches – Identification and Transformation **Vocabulary :** 1. Affixes 2. Countable and Uncountable nouns 3. Global Management **Writing :** 1.Memo 2. Notice with agenda 3. Email : Requesting information **Reading :**Corporate gift-giving, New places, New people, Team Building and Thinking globally : 1. Career Advice : letters to an advice column 2. Promotional gifts : an article 3. Descriptions of team building events; Kaizen : an article 4. Global HR management : an Article. **Lab Activities(Speaking):** Role Play : 1. Interviewing someone about a job change 2. Discussion : Planning a team building event 3. Promoting a city : giving a speech. **Lab Activities(Listening) :** 1. An interview with someone who has changed career 2. An interview about corporate gift giving 3. Creating good teams : a Presentation 4. Working an international Team : short Extracts.	**CO-4** **BTL-3**
MODULE 5 : English for Presentation	**(6L + 6P=12)**
Grammar :1. Adjectives and adverbs 2. Pronouns and Reference Words 3. Types of Sentences – Simple, Compound and complex Sentences – Identification and transformation. **Vocabulary :**1. Describing Trends 2. Finance Vocabulary 3. Stocks and Shares 4. Collocation - sets and money **Writing** : 1. Transcoding – Converting an image (Linegraph, piechart, bar chart, flowchart tree diagram etc.,) into a paragraph – Converting a paragraph into an image(Linegraph, piechart, bar chart, flowchart tree diagram etc.,) 2. Summary writing **Reading :**Describing Statistics, Company finances, investments and starting up : 1.	**CO-5** **BTL-4**

Interpreting bar charts 2. Café Coffee day : an article on the growth of the Indian coffee shop. 3. Shares and the stock exchange: a web page; short articles from the financial news; men and women investments : an article 4. Teenage entrepreneus : reading and comparing two articles; Kalido: an article on funding. **Lab Activities(Speaking) :** 1. Describing figures and trends 2. Discussing qualities needed in candidates for a job vacancy **Lab Activities(Listening) :** 1. Listening to statistical information : short extracts 2. An interview with the employee of a company that helps failing business 3. An interview with someone who works in investor relations. 4. Radio interview : marketing director of a business support service.	

TEXT BOOK	
1	Whitby, Norman (2019). Cambridge English Business Benchmark, Pre-intermediate and Intermediate. Cambridge University Press. India (Pages 208)
REFERENCE BOOKS	
1.	Murphy, Raymond(2021). Essential English Grammar, Cambridge University Press. India
2.	Redman, Stuart(2020).English Vocabulary In Use: Pre - Intermediate And Intermediate. Cambridge University Press. India (Pages 264)
3.	Bikram K. Das. et al.,(2019) An Introduction to Professional English and Soft Skills with audio CD, Cambridge University Press. India (Pages 272)
4.	John, Dolly., (2018), English for Life and the Workplace Through LSRW&T Skills, Pearson Publications.India (Pages 263)
E BOOKS	
1.	https://www.cambridge.org/gb/files/9116/4138/4615/A1_Student_Book.pdf
2.	https://www.cambridge.org/gb/files/1416/4138/4681/A1_Workbook.pdf
3.	https://www.cambridge.org/gb/files/7216/4138/1999/A2_Student_Book.pdf
4.	https://www.cambridge.org/gb/files/6816/4138/2072/A2_Workbook.pdf
MOOC	
1.	https://www.edx.org/professional-certificate/tsinghuax-english-communication-skills
2.	https://www.britishcouncil.org.tr/en/english/mooc/english-for-the-workplace

COURSE TITLE	INNOVATION LAB FOR CHEMICAL ENGINEERS			CREDITS	2
COURSE CODE	ECH51401	COURSE CATEGORY	ES	L-T-P-S	0-1-2-2
Version	1.0	Approval Details		LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Weekly assignment/Observation / lab records as approved by DEC	Surprise Test / Quiz as approved by DEC	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	An innovation lab is a novel kind of physical space that encourages the creation, development, and implementation of novel ideas in chemical engineering
Course Objective	The students will be able 1. To apply a new method for improving the experimental performance 2. To explain the importance of biogas plants 3. To demonstrate the applications of membranes effectively 4. To explain the unit operations to promote industrial activities 5. To analyse the usage of solar energy in vital sectors
Course Outcome	After successful completion of innovation lab, the student will be able to 1. Sketch the concept of innovation to develop new method to improve the performance of a product/process. 2. Organize design configuration to set up biogas plant. 3. explain the application of membrane technology to screen impurities 4. Demonstrate protocol to perform extraction and adsorption techniques 5. Apply and develop solar panels for various applications

Prerequisites: NIL

CO, PO AND PSO MAPPING

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

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:INNOVATIVE THINKING (3L+6P)

Innovation methodology; Creation of ideas: new ideas generation and presentation. Exploring various possibilities of design and principles; Technical report writing, data collection and generation of charts with excel. **Lab component:** PowerPoint presentation of a novel product design/process design in chemical industries.	**CO-1** **BTL-3**
MODULE 2:BIOGAS	**(3L+6P)**
Properties of biogas - calorific value and its composition. Types of Biogas plants, Basic design of a biogas plant. Operational aspect of a typical biogas plant. **Lab component:** Demonstrate innovative design concepts of biogas plant and analysing its properties.	**CO-2** **BTL-3**
MODULE 3: MEMBRANES IN PROCESS INDUSTRIES	**(3L+6P)**
Overview and types of membranes, Material properties and preparation of phase-inversion membranes, Preparation of composite and inorganic membranes, Electrodialysis, Pervaporation, Problems and solutions based on ED, PV Lab component: Design a membrane system for novel application	**CO-3** **BTL-3**
MODULE 4:UNIT OPERATIONS	**(3L+6P)**
Extraction – extractors – Types of extractors, solvents used in extraction process – industrial applications, Adsorption – Types of absorbers, adsorbents- properties of adsorbents – mode of operation – Industrial applications. **Lab component:** Organize a protocol to extract valuable components from any source to develop a product (liquid – liquid extraction) Prepare a method to remove toxic elements using adsorbents.	**CO-4** **BTL-3**
MODULE 5:SOLAR ENERGY	**(3L+6P)**
Solar energy – an overview of Thermal Applications, solar radiation, non concentrating solar collectors, parabolic solar collectors, thermal energy storage systems **Lab component:** Analysing the design and fabrication of solar panels.	**CO-5** **BTL-3**

TEXTBOOKS	
1	Haik, Y., Shahin, M. T. (2013). *Engineering Design Process*, Cengage Learning Publications, 1st Edition.
2	Richard w. baker. (2012). *Membrane Technology and Applications*, John Wiley and Sons Ltd, Third edition.

3.	Elias G. Carayannis., Elpida T. Samara., Yannis L. Bakouros., (2015). *Innovation and Entrepreneurship - Theory, Policy and Practice*, Springer, 1st Edition.
REFERENCE BOOKS	
1	Teodorita Al Seadi., Dominik Rutz., Heinz Prassl., Michael Köttner., Tobias Finsterwalder., Silke Volk., Rainer Janssen. (2008). *Biogas Handbook*, University of Southern Denmark Esbjerg, Niels Bohrs Vej , 1st Edition.
2	Anbumozhi, V., Thangavelu, S. M., Visvanathan, C. (2013). *Eco-Industrial Clusters: A prototype training manual*.Asian Development Bank Institute, 1st Edition.
3.	D. Yogi Goswami. (2015). *Principles of Solar engineering*, CRC Press, Third edition.
E BOOKS	
1. 2.	**https://www.redhat.com/en/resources/open-innovation-labs-ebook** **https://www.reallygoodinnovation.com/books/innovation-lab-ebook**
MOOC	
1. 2. 3.	https://onlinecourses.nptel.ac.in/noc21_de01/preview https://www.digimat.in/nptel/courses/video/110107094/L05.html http://www.sustainability-and-social-innovation.com/social-innovation-619134.html

COURSE TITLE	BASIC TAMIL			**CREDITS**	**2**
COURSE CODE	**ELS51003**	**COURSE CATEGORY**	**HS**	**L - T – P – S**	**2 – 0 – 0 – 1**
Version	**1.0**	**Approval Details**	**35th ACM 6th Aug. 2022**	**LEARNING LEVEL**	**BTL- 3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz etc., as approved by the Department Examination Committee "DEC"	Attendance	End Semester Examination ESE
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This Tamil course improves Tamil language skills of the students' Tamil letters and Grammar are included. This course provides an opportunity not only to get interest in learning Tamil Language but also they can learn to converse easily.

Course Objective	1. By studying this course, students will be able to write and speak Tamil easily in any situation, daily life and daily conversations. 2. Develops language and interest in learning in students. 3. Facilitates students to create opportunities for themselves in the society. 4. Students also learn Tamil literature by developing interest in language department. 5. This lesson plan helps the students to learn about the culture by learning the Tamil language.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the Letters and basic words of Tamil Language which are in daily use 2. Develops the listening skills of Tamil language 3. Utilize the letters and common words of the language for communication 4. Develop the conversational skills 5.Demonstrate the skill of reading and writing

Prerequisites: Plus Two -Intermediate Level

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	-	3	-	-	To be marked by respective department		
CO2	-	-	-	-	-	-	-	2	2	3	-	-			
CO3	-	-	-	-	-	-	-	-	-	3	-	-			
CO4	-	-	-	-	-	-	2	-	-	3	2	-			
CO5	-	-	-	-	-	-	-	-	2	3	2	3			

1: Weakly related, 2: Moderately related and 3: Strongly related

அலகு - 1 **தமிழ் எழுத்துக்கள்** **(6 L)**

தமிழ் எழுத்துகள் – ஓசைகள் - எண்கள் – வண்ணங்கள் – வடிவங்கள் - ஓர் எழுத்துச் சொற்கள் - பழங்கள் மற்றும் காய்கறிகள் – மலர்கள் – இயற்கை - மாதங்கள் சொற்கள் - பெயர்சொற்கள் – உரிச்சொற்கள் – வினைச்சொற்கள் – காலங்கள் - வாழ்த்துகள். **வகுப்பறை செயல்முறைகள்**: 1. **வார்த்தைகளை வட்டமிடுதல்.** 2. **விடுபட்ட எழுத்துகளை நிரப்புக.** 3. **வடிவங்களுக்கு வண்ணம் தீட்டுக.**	**CO-1** **BTL-2**

அலகு – 2**கேட்டல் மற்றும் உச்சரித்தல்**(6L)

உயிரெழுத்துகள்,மெய்யெழுத்துகள் மற்றும் உயிர்மெய் எழுத்துகளை	**CO-2**

உச்சரித்தல் - சிறுகதைகள் வாசித்தல் – எதிர்ச்சொற்கள் - பொருள்தருக – வாக்கியத்தில் அமைத்து எழுதுதல் – ஒரு சொல்லில் விடையளித்தல். வகுப்பறை செயல்முறைகள் : 1. சொற்களைக் கேட்டு உச்சரிக்க செய்தல். 2. குழுவிவாதம் செய்தல். 3. கோடிட்ட இடங்களைச் சரியான சொற்களைக் கூறுதல்.	BTL-2
அலகு -3எழுத்துப்பயிற்சி (6 L)	
தமிழ் எழுத்துகளை எழுத கற்பித்தல்- உயிர் எழுத்துகள் - மெய் எழுத்துகள் - உயிர்மெய் எழுத்துகள் - ஆயுத எழுத்து – சார்பெழுத்துகள் – ஒற்றெழுத்துகள் - ஒரு சொல் - இருசொல் எழுதுதல் – ஒருவரி, இருவரி எழுதுதல். வகுப்பறை செயல்முறைகள்: 1. கோடிட்ட இடங்களை நிரப்புக. 2. சரியான எழுத்துகளை வட்டமிடுதல். 3. ஒருவரி சொற்களை எழுதுதல்.	CO-3 BTL-3
அலகு - 4உரையாடல்கள்கற்பித்தல்(6 L)	
சிறு உரையாடல்கள் கற்பித்தல் – வாழ்த்துக்கள் - வங்கியில் பணம் செலுத்துதல் - சந்தையில் கடைகாரரிடம் உரையாடுதல், பொது இடங்களில் உரையாடுதல். வகுப்பறை செயல்முறைகள்: 1. குறு நாடகங்கள் நடித்து உரையாடல்கள் கற்பித்தல். 2. விண்ணப்ப படிவங்கள் பூர்த்தி செய்தல். 3. மின்னல் அட்டைகள் காண்பித்தல்.	CO-4 BTL-2
அலகு - 5தமிழ் வாசிக்க மற்றும் எழுத கற்பித்தல்(6 L)	
கடிதங்கள் வாசித்தல் மற்றும் எழுதுதல் – விண்ணப்ப கடிதம், வங்கிகணக்கு படிவங்கள், இரயில் முன்பதிவு விண்ணப்ப படிவம் பூர்த்திசெய்தல் – கவிதை வாசித்தல் – செய்திதாள் வாசித்தல். வகுப்பறை செயல் முறைகள்: 1. விண்ணப்ப படிவங்கள் பூர்த்திசெய்தல். 2. கவிதை வாசித்தல் போட்டிகள் 3. வகுப்பறை தேர்வுகள்	CO-5 BTL-3

TEXT BOOK	
1.	Saidhai. P.Sundaramurthy (2018). Learn Tamil Through English. ManimekalaiPrasuram. Chennai - 17.Pages 1 to 84
2.	PulavarKulanthai (2020). Students Basic Tamil. ManimekalaiPrasuram. Chennai -17. Pages1 to 84
REFERENCE BOOKS	
1.	Lenatamilvanan. (2017). Easy Tamil Grammar. ManimekalaiPrasuram, Chennai -17,Pages 11 to 21
2.	Tamilnadu Board - NCERT/CBSE-Books Class – 6^{th} TO 9^{th} (2021-2022)
E-REFERENCES	
1	https://cbsetamil.com/cbse-tamil-book/,https://tamil.examsdaily.in/tnpsc-tamil-ilakkanam-material-pdf-

	download

COURSE TITLE	Hindi			CREDITS	2
COURSE CODE	ELS5100	COURSE	HS	L - T – P – S	2 – 0 – 0 – 1
VERSION	1.	APROVAL	35th ACM 6th Aug. 2022	BTL LEVEL	3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz etc., as approved by the Department Examination Committee "DEC"etc	Attendance	End Semester Examination ESE
15%	15%	10%	5%	5%	50%

Course Description	This course has been designed to develop the regional language skills of the students. The course includes Hindi language, literature, vocabulary and grammar. This course teaches students how to communicate accurately, appropriately and fluently in regional language.
Course Objective	1. To provide an environment to Speak and write in Hindi at the formal and informal levels and use it for daily conversation, presentation, group discussion and debate. 2. To equip the students to Read, comprehend and answer questions based on literary texts. 3. To help student to become sensitive to the requirements of the society and respond to it in a constructive way. 4. To provide an environment to students to read and appreciate the literature.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the ability to write the grammatically correct sentences with accuracy. 2. Integrating various components of Hindi Language and determining it through reading and listening. 3. Organize and articulate ideas, concepts, and perceptions in a comprehensive manner in written correspondence, and speaking in formal and informal situations. 4. Infer details from after listening and reading and implement it in various professional situations. 5. Develop writing and speaking skills.

Prerequisites: Plus Two -Intermediate Level

CO, PO AND PSO MAPPING

CO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PS	PSO3
CO1	-	-	-	-	-	-	-	-	-	3	-	-	To be marked by respective department		
CO2	-	-	-	-	-	-	-	2	2	3	-	-			
CO3	-	-	-	-	-	-	-	-	-	3	-	-			
CO4	-	-	-	-	-	-	2	-	-	3	2	-			
CO5	-	-	-	-	-	-	-	-	2	2	-	2			

1: Weakly related, 2: Moderately related and 3: Strongly related

मॉड्यूल 1: **हिंदी पत्र और लिपि** (6 L)

हिंदी स्वर और व्यंजन अक्षर - आश्रित स्वर सीखें - व्यंजन और व्यंजन समूह - अनुस्वर व्यंजन - संज्ञा - सर्वनाम - क्रिया (भविष्य) - संभावित विशेषण - काल - हिंदी के त्वरित नियम - अभिवादन - 2 अक्षर शब्द बनाना, 3 अक्षर शब्द - हर दिन शब्दावली - संख्याएं - रंग - परिवार - वस्त्र - बगीचा - घर - फल और सब्जियां - प्रकृति	CO-1 BTL-2

सुझाई गई गतविधियिां: देशी वक्ताओं द्वारा स्वर और व्यंजन का उच्चारण सुनना स्वर और व्यंजन के वीडियो, 2 अक्षर और 3 अक्षर के शब्द, और प्रतिदिन प्रयोगार्थ शब्दावली	
मॉड्यूल 2: सुनने का कौशल	(6 L)
स्वर और व्यंजन का उच्चारण सुनना - लघु कथाएँ सुनना - साक्षात्कार - भाषण - सामाजिक मुद्दों पर पॉड वार्ता - निर्धारित पाठों को सुनना: इकाई 1 सभ्यता का रहस्य, इकाई 2 - युवावों से - वार्तालापों को सुनना - जानकारी सुनना - सम्मेलनों के भाषण **सुझाई गई गतविधियिां**: सुनें और चुनें उम्मीदवार पाठ को सुनते हैं और तीन विकल्पों के साथ बहुविकल्पीय प्रश्न का उत्तर देते हैं। उम्मीदवार टीवी चैनलों में बातचीत - साक्षात्कार- अतिथि व्याख्यान, सम्मेलनों और कार्यशालाओं के दौरान विशेषज्ञों के भाषण सुनते हैं	CO-2 BTL-3
मॉड्यूल 3: बोलने का कौशल	(6 L)
औपचारिक संवाद - अनौपचारिक संवाद - लिंग रूपों के साथ बोलना - संख्या - काल - परिवार, शहर, त्योहारों, शौक आदि जैसे सामान्य विषयों पर बोलना - पसंद और नापसंद व्यक्त करना - ज़रूरतें और संपत्ति - भूमिका निभाना। **सुझाई गई गतविधियिां:** प्रस्तुति – कार्यक्रमों का संचालन - भाषण देना	CO-3 BTL-3
मॉड्यूल- 4 : पढ़ने का कौशल	(6 L)
नमूना पढ़ना - नकल पढ़ना - अक्षरों और शब्दों का सही उच्चारण करना - पढ़ने में प्रवाह - कहानियाँ पढ़ना- संपादकीय, समाचारपत्र के लेख पढ़ना। **सुझाई गई गतविधियिां** फ्लैशकार्ड का उपयोग - चार्ट - चित्रों की पहचान करना - शब्दों को पढ़ना	CO-4 BTL-3
मॉड्यूल-5 लेखन कौशल	(6 L)
सामान्य पत्राचार - पत्र लेखन: छुट्टी लेने पत्र, बैंक खाता खोलना, पुस्तकें मंगवाने के लिए पत्र, शिकायत पत्र - संकेत विकास - ज्ञापन - नोटिस **सुझाई गई गतविधियिां:** निर्धारित पाठ्यपुस्तक के अनुसार अभ्यास पूरा करना	CO-5 BTL-3
पाठ्य पुस्तक	
1.	Sashtri. S.R.(2019). Hindi Shikshak, Dakshina Bharat Hindi Prachar Sabha, Chennai (Pages 137)
संदर्भ पुस्तकें	

1.	Prathamatic Patya Pushthak. (2022), Dakshina Bharath Hindi Prachar Sabha, Chennai. (Pages 168)
2.	Madhyama Patya Pushthak. (2022) Dakshina Bharath Hindi prachar Sabha, Chennai (Pages 184)
ई-संदर्भ	
1.	https://www.hindipod101.com/

COURSE TITLE	**TELUGU**			**CREDITS**	**2**
COURSE CODE	**ELS51005**	**COURSE CATEGORY**	**HS**	**L - T – P – S**	**2 – 0 – 0 – 1**
Version	**1.0**	**Approval Details**	**35th ACM 6th Aug.**	**BTL LEVEL**	**3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments / Project	Surprise Test / Quiz etc., as approved by the Department Examination Committee "DEC"etc.,	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course has been designed to meet students' current and future language and communication needs. It attempts to develop their proficiency in the four language skills and knowledge of grammar and vocabulary. This course teaches students how to communicate accurately, appropriately and fluently in professional and social situations.
Course Objectives	1. This course is aimed to teach the basic Telugu language speaking skills. 2. It will introduce basic skills of the Telugu Language: its alphabets, essential words and simple sentence construction methods. 3. The course intends to facilitate students in acquiring foundational skills of reading, writing and speaking Telugu along with synonyms to expand vocabulary.
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate the basic skills of Letters and sounds in Telugu. 2. Develop the basic vocabulary for everyday's conversation. 3. Construct simple Telugu sentences with the simple words. 4. Utilize the words that have conjunct character, and can learn functional, everyday conversation. 5. Construct Simple sentences for delivering appropriate meaning.

Prerequisites: Plus Two Telugu-Intermediate Level

CO, PO AND PSO MAPPING

CO	PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO	PSO3
CO1	-	-	-	-	-	-	-	-	-	3	-	-	To be marked by respective department		
CO2	-	-	-	-	-	-	-	2	2	3	-	-			
CO3	-	-	-	-	-	-	-	-	-	3	-	-			
CO4	-	-	-	-	-	-	2	-	-	3	2	-			
CO5	-	-	-	-	-	-	-	-	-	3	-	2			

1: Weakly related, 2: Moderately related and 3: Strongly related

భాగము 1 : వినడం, చెప్పడం మరియు రాయడం (6L)	
తెలుగు అచ్చులు & హల్లులు శబ్దాలు ధ్వనిచిత్రంతో పాటు తెలుగు హల్లుల సంయోగాల పరిచయం సూచించబడిన : కార్య కలాపాలు చర్చలు : 5 గంటలు . అసైన్‌మెంట్లు / ప్రెజెంటేషన్ - 5 గంటలు	**CO-1** **BTL-2**
భాగము 2 : పేర్ల పదాలకు, సంఖ్యలకు, మరియు వాటి గుణాల పరిచయం (6L)	
తెలుగు నామవాచకం పరిచయం తెలుగు సర్వనామం & దాని విషయం సంఖ్యలు దాని పరిచయం & తెలుగు విశేషణాలు పరిచయం సూచించబడిన : కార్య కలాపాలు చర్చలు : 5 గంటలు . అసైన్‌మెంట్లు / ప్రెజెంటేషన్ - 5 గంటలు	**CO-2** **BTL-3**
భాగము 3 : పదాలను విడదీసి వాక్యాలను రాయడం (6L)	
తెలుగు పూర్వ పదాలు – సంయోగాలు మరియు దాని ఉపయోగం సూచించబడిన : కార్య కలాపాలు చర్చలు : 5 గంటలు . అసైన్‌మెంట్లు / ప్రెజెంటేషన్ - 5 గంటలు	**CO-3** **BTL-3**
భాగము 4 : పనులు, సమయం, క్రియ మరియు కాల వ్యవధుల పరిచయం (6L)	
వివిధ క్రియల యొక్క క్రియ & సమయం / కాల సంయోగాలనికి పరిచయం సూచించబడిన : కార్య కలాపాలు చర్చలు : 5 గంటలు . అసైన్‌మెంట్లు / ప్రెజెంటేషన్ - 5 గంటలు	**CO-4** **BTL-3**
భాగము 5 : తెలుగు చదవడం, రాయడం మరియు ప్రశ్నించడం (6L)	
తెలుగులో సరళమైన వాక్యాలను రూపొందించడం (ప్రాథమిక వాక్య నిర్మాణ నియామాలు) తెలుగులో ప్రతీకూల వాక్యాలును రూపొందించడం తెలుగు బోధన అభ్యాస ప్రక్రియలో ప్రశ్నార్థకవాక్యాలువాక్యాలను రూపొందించడం సూచించబడిన : కార్య కలాపాలు చర్చలు : 5 గంటలు . అసైన్‌మెంట్లు / ప్రెజెంటేషన్ - 5 గంటలు	**CO-5** **BTL-3**

TEXT BOOK	
1.	Telugu Akademy. (2018). Sampradaya Telugu Vyakaranalu. Telugu Akademy. Vijayawada, Andhra Pradesh. India.
2.	**Raghavendra. A. (2019). Telugu Vyakaranam.** Prajasakti Book House. Tadepalli.
REFERENCE BOOKS	
1.	Ramarao, Chekuri. (2019). A Reference Grammar of Modern Telugu. Emesco Books. Hyderabad
2.	Vemuri, V. Rao. (2020). Learn Telugu with Its Grammar, Eco Foundation, Vijayawada.
E-References	
1	https://sarkarihelp.com/telugu-grammar-pdf-download/