B.Tech in
Aerospace Engineering

Faculty of Engineering

Revised in June 2015

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Vision of the Institute

To be a global leader in the delivery of engineering education, transforming individuals to become creative, innovative, and socially responsible contributors in their professions.

Mission of the Institute

- To provide best-in-class infrastructure and resources to achieve excellence in technical education,
- To promote knowledge development in thematic research areas that have a positive impact on society, both nationally and globally,
- To design and maintain the highest quality education through active engagement with all stakeholders – students, faculty, industry, alumni and reputed academic institutions,
- To contribute to the quality enhancement of the local and global education ecosystem,
- To promote a culture of collaboration that allows creativity, innovation, and entrepreneurship to flourish, and
- To practice and promote high standards of professional ethics, transparency, and accountability

Vision of the Department

To be the best Department of Aerospace Engineering known for its teaching, research, applied engineering and service to society.

Mission of the Department

M1-Teaching: Updating the curriculum and continuously improving the pedagogy to keep pace with advances in the field of Aerospace Engineering, reflecting the interdisciplinary nature of this technology domain.

M2-Research: Inculcating research interest in students by offering state of the art and multidisciplinary topics as final year projects.

M3-Applied Engineering: Including lab courses and design projects, both involving open-ended problems, which need innovative approach, as part of the curriculum**.**

M4-Service to Society: Imparting knowledge on environmental issues related to Aerospace Engineering and including value based programs to make the student appreciate societal needs.

PROGRAM EDUCATIONAL OUTCOMES (PEOs)

PEO1 is strongly mapped with the M1 and M2 because they assist students to confidently pursue higher studies and research.

PEO2 is strongly mapped to M1, M2 and M3 as they enable the students to work in core aerospace industry, which involves diverse technology domains.

PEO3 is strongly mapped with M2 and M3 because of its emphasis on research and applied engineering, which helps the students to become successful entrepreneurs.

PEO4 is strongly mapped to M4 as it emphasizes on environmental and value based programs which will enable the students to them to appreciate societal/national requirements.

PEO5 is strongly mapped to M1, M2 and M3 as they will enable the students to perform well in any field allied to the fundamentals of Aerospace engineering.

PEO\M	M1	M2	M3	M4
PEO1	3	3	2	1
PEO2	3	3	3	1
PEO3	1	3	3	2
PEO4	1	1	2	3
PEO5	3	3	3	1

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Students will learn governing principles in the fundamental disciplines of Aerospace Engineering (covering aerodynamics, guidance & control, propulsion and structures) along with their applications.

2. Students will be trained in the methodology and tools that are used in the fundamental design of aircraft and rockets.

3. Students will have the ability to function in multidisciplinary teams in the Aerospace Engineering domain.

PROGRAM OUTCOMES (PO)

Engineering Graduates will be able to:

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

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

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

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

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

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

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions insocietal and environmental contexts, and demonstrate the knowledge of, and need for sustainabledevelopment.

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

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

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

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

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

PO_PEO Mapping

Program Name:	**Aerospace Engineering**				
Affinity Label -	0,1,2,3				
	Aero - PEO1	**Aero - PEO2**	**Aero - PEO3**	**Aero - PEO4**	**Aero – PEO5**
Aero - PSO1	**3**	**2**	**1**	**1**	**3**
Aero - PSO2	**3**	**3**	**2**	**1**	**1**
Aero - PSO3	**1**	**3**	**2**	**2**	**3**
Aero - PO1	**3**	**3**	**2**	**1**	**3**
Aero - PO2	**3**	**3**	**2**	**2**	**3**
Aero - PO3	**2**	**3**	**2**	**3**	**2**
Aero - PO4	**3**	**2**	**2**	**1**	**3**
Aero - PO5	**3**	**3**	**3**	**2**	**3**
Aero - PO6	**1**	**1**	**3**	**3**	**2**
Aero - PO7	**2**	**2**	**2**	**3**	**2**
Aero - PO8	**2**	**2**	**3**	**3**	**1**
Aero - PO9	**1**	**2**	**3**	**2**	**3**
Aero - PO10	**3**	**3**	**3**	**2**	**2**
Aero - PO11	**1**	**3**	**3**	**2**	**2**
Aero - PO12	**3**	**2**	**3**	**3**	**3**

Semester I					
Cat.	**Code**	**Course Title**	**L-T-P**	**Cr**	**ES**
HUM	15ENG111	Communicative English	2 0 2	3	A
SCI	15MAT111	Calculus and Matrix Algebra	2 1 0	3	B
ENGG	15CSE100	Computational Thinking and Problem Solving	3 0 2	4	D
SCI	15PHY100/ 15CHY100	Physics / Chemistry	3 0 0	3	C
SCI	15PHY181/ 15CHY181	Physics Lab. / Chemistry Lab.	0 0 2	1	L1
ENGG	15MEC180/ 15EEE180	Workshop A/ Workshop B	0 0 2	1	L2
ENGG	15MEC100	Engineering Drawing - CAD	2 0 2	3	E
HUM	15CUL101	Cultural Education I	2 0 0	2	F
				Total	**20**

Semester II					
Cat.	**Code**	**Course Title**	**L-T-P**	**Cr**	**ES**
SCI	15MAT121	Vector Calculus and Ordinary Differential Equations	3 1 0	4	B
SCI	15CHY100/ 15PHY100	Chemistry/ Physics	3 0 0	3	C
ENGG	15CSE102	Computer Programming	3 0 0	3	D
ENGG	15MEC102	Engineering Mechanics	3 0 0	3	E
ENGG	15AES111	Introduction to Aerospace Technology	3 0 0	3	A
SCI	15CHY181/ 15PHY181	Chemistry Lab. / Physics Lab.	0 0 2	1	L1
ENGG	15EEE180/ 15MEC180	Workshop B/ Workshop A	0 0 2	1	L2
ENGG	15CSE180	Computer Programming Lab.	0 0 2	1	L3
HUM	15CUL111	Cultural Education II	2 0 0	2	F
				Total	**21**

Semester III					
Cat.	**Code**	**Course Title**	**L-T-P**	**Cr**	**ES**
ENGG	15AES201	Mechanics of Fluids	3 1 0	4	A
ENGG	15AES202	Introduction to Thermodynamics	2 1 0	3	C
ENGG	15AES203	Mechanics of Materials	2 1 0	3	D
ENGG	15AES204	Materials for Aviation and Space	3 0 0	3	E
SCI	15MAT204	Transforms and Partial Differential Equations	2 1 0	3	B
SCI		Science Elective I	2 1 0	3	G
HUM		Humanities Elective I		2	H
ENGG	15AES281	Measurement and Instrumentation Lab.[@]	0 0 2	1	L1
HUM	15AVP201	Amrita Values Programme I	1 0 0	1	F
				Total	**23**

Semester IV					
Cat.	**Code**	**Course Title**	**L-T-P**	**Cr**	**ES**
ENGG	15AES211	Aerodynamics I	3 0 0	3	A
ENGG	15AES212	Compressible Fluid Flow	2 1 0	3	C
ENGG	15AES213	Aerospace Structures I	3 0 0	3	D
ENGG	15AES214	Introduction to Control Theory	2 1 0	3	E
SCI	15MAT211	Calculus of Variations and Numerical Methods	2 1 0	3	B
HUM		Humanities Elective II		2	H
ENGG	15AES285	Mechanics of Fluids Lab.	0 0 2	1	L1
ENGG	15AES286	Materials Testing Lab.[@]	0 0 2	1	L2
HUM	15SSK221	Soft Skills I	1 0 2	2	G
HUM	15AVP211	Amrita Values Programme II	1 0 0	1	F
				Total	**22**

[@] 'Hands-on' Project-based Lab.

Semester V					
Cat.	**Code**	**Course Title**	**L-T-P**	**Cr**	**ES**
ENGG	15AES301	Aerodynamics II	2 1 0	3	A
ENGG	15AES302	Aerospace Propulsion	2 1 0	3	C
ENGG	15AES303	Aerospace Structures II	3 0 0	3	D
ENGG	15AES304	Avionics	3 0 0	3	F
SCI	15MAT202	Linear Algebra	2 1 0	3	B
ENGG		Elective I*	3 0 0	3	E
ENGG	15AES381	Aero-structures Lab.[@]	0 0 2	1	L1
ENGG	15AES382	Avionics Lab.[@]	0 0 2	1	L2
HUM	15SSK321	Soft Skills II	1 0 2	2	G
ENGG	15AES390	Live-in-Lab**		[3]	P2
				Total	**22 [+3]**

Semester VI					
Cat.	**Code**	**Course Title**	**L-T-P**	**Cr**	**ES**
ENGG	15AES311	Finite Element Methods for Aerospace	2 1 0	3	A
ENGG	15AES312	Flight Mechanics	2 1 0	3	B
HUM	15ENV300	Environmental Science and Sustainability	3 0 0	3	C
ENGG		Elective II*	3 0 0	3	E
SCI		Science Elective II	3 0 0	3	H
ENGG	15AES383	Propulsion Lab.[@]	0 0 2	1	L1
ENGG	15AES384	Low-speed Aerodynamics Lab.[@]	0 0 2	1	L2
ENGG	15AES385	Innovations Lab.	0 0 2	1	L3
HUM	15SSK331	Soft Skills III	1 0 2	2	G
				Total	**20**

'Hands-on' Project-based Lab.

* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester.

Semester VII

Cat.	Code	Course Title	L-T-P	Cr	ES
ENGG	15AES401	Computational Fluid Dynamics for Aerospace	2 1 0	3	A
ENGG	15AES402	Aero Design	2 2 2	5	B
ENGG	15AES382	Avionics Lab.[@]	3 0 0	3	C
ENGG		Elective III*	3 0 0	3	E
ENGG		Elective IV*	3 0 0	3	D
ENGG	15AES481	UAV Lab.[@]	0 0 2	1	L1
PRJ	15AES495	Project Phase I		2	P1
ENGG	15AES490	Live-in-Lab**		[3]	P2
				Total	**20 [+3]**

Semester VIII					
Cat.	**Code**	**Course Title**	**L-T-P**	**Cr**	**ES**
ENGG		Elective V*	3 0 0	3	E
ENGG		Elective VI*	3 0 0	3	D
PRJ	15AES499	Project Phase II		10	P
				Total	**16**

@ ‘Hands-on’ Project-based Lab.

"* A maximum of One Elective course can be chosen from the Electives prescribed for other Branches or from under Science Electives.

** Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for an Elective course in the higher semester."

ELECTIVES

Elective I

15AES332	Fundamentals of Heat Transfer
15AES352	Vibration Analysis
15AES372	Manufacturing Processes

Elective II

15AES342	Experimental Aerodynamics
15AES353	Composite Materials and Mechanics
15AES373	Advanced Avionics

Elective III

15AES432	Air Breathing Engines
15AES452	Engineering Fracture Mechanics
15AES462	Helicopter Theory

Elective VI

15AES430	Rocket and Spacecraft Propulsion (O)
15AES442	Hypersonic Flow Theory
15AES453	Aero-Elasticity
15AES454	Advanced Composite Structures
15AES470	State Space Techniques (O)

Elective V

15AES440	Turbulent Flows (O)
15AES460	Space Flight Mechanics (O)
15AES471	Multidisciplinary Design Optimization (O)

Elective VI

15AES441	Advanced Computational Fluid Dynamics (O)
15AES450	Surface Engineering, Coating and Joining Technologies (O)
15AES461	Principles of Airport Management (O)

(O) *indicates Open electives which can be taken by students of other branches.*

SCIENCE ELECTIVES

15CHY231 Advanced Polymer Chemistry

15CHY232 Biomaterials Science

15CHY233 Catalytic Chemistry

15CHY234 Chemistry of Advanced Materials

15CHY235 Chemistry of Engineering Materials

15CHY236 Chemistry of Nanomaterials

15CHY237 Chemistry of Toxicology

15CHY238 Colloidal and Interfacial Chemistry

15CHY239 Computational Chemistry and Molecular Modelling

15CHY241 Electrochemical Energy Systems and Processes

15CHY242 Environmental Chemistry

15CHY243 Fuels and Combustion

15CHY244 Green Chemistry and Technology

15CHY245 Instrumental Methods of Analysis

15CHY246 Medicinal Organic Chemistry

15CHY247 Modern Polymer Composites

15CHY248 Organic Reaction Mechanisms

15CHY249 Organic Synthesis and Stereochemistry

15CHY250 Polymer Materials and Properties

15CHY251 Polymers for Electronics

15CHY252 Solid State Chemistry

15CHY331 Batteries and Fuel Cells

15CHY332 Corrosion Science

15PHY230 Advanced Classical Dynamics

15PHY233 Biophysics and Biomaterials

15PHY234 Introduction to Computational Physics

15PHY238 Electrical Engineering Materials

15PHY239 Electromagnetic Fields and Waves

15PHY240 Electronic Material Sciences

15PHY241 Lasers in Material Processing

15PHY245 Nuclear Energy – Principles and Applications

15PHY247 Photovoltaics

15PHY248 Physics of Lasers and Applications

15PHY250 Quantum Physics and Applications

15PHY251 Thin Film Physics

15PHY331 Astronomy

15PHY333 Concepts of Nanophysics and Nanotechnology

15PHY335 Medical Physics

15PHY338 Physics of Semiconductor Devices

15PHY532 Astrophysics

15PHY535 Earth's Atmosphere

15PHY536 Earth's Structure and Evolution

15PHY540 Nonlinear Dynamics

15PHY542 Optoelectronic Devices1

HUMANITIES ELECTIVES

15CUL230	Achieving Excellence in Life - An Indian Perspective	2 0 0	2
15CUL231	Excellence in Daily Life	2 0 0	2
15CUL232	Exploring Science and Technology in Ancient India	2 0 0	2
15CUL233	Yoga Psychology	2 0 0	2
15ENG230	Business Communication	1 0 2	2
15ENG231	Indian Thought through English	1 0 2	2
15ENG232	Insights into Life through English Literature	1 0 2	2
15ENG233	Technical Communication	1 0 2	2
15ENG234	Indian Short Stories in English	1 0 2	2
15FRE230	Proficiency in French Language (Lower)	1 0 2	2
15FRE231	Proficiency in French Language (Higher)	1 0 2	2
15GER230	German for Beginners I	1 0 2	2
15GER231	German for Beginners II	1 0 2	2
15GER232	Proficiency in German Language (Lower)	1 0 2	2
15GER233	Proficiency in German Language (Higher)	1 0 2	2
15HIN101	Hindi I	1 0 2	2
15HIN111	Hindi II	1 0 2	2
15HUM230	Emotional Intelligence	2 0 0	2
15HUM231	Glimpses into the Indian Mind - the Growth of Modern India	2 0 0	2
15HUM232	Glimpses of Eternal India	2 0 0	2
15HUM233	Glimpses of Indian Economy and Polity	2 0 0	2

15HUM234	Health and Lifestyle	1 0 2	2
15HUM235	Indian Classics for the Twenty-first Century	2 0 0	2
15HUM236	Introduction to India Studies	2 0 0	2
15HUM237	Introduction to Sanskrit Language and Literature	2 0 0	2
15HUM238	National Service Scheme	2 0 0	2
15HUM239	Psychology for Effective Living	2 0 0	2
15HUM240	Psychology for Engineers	2 0 0	2
15HUM241	Science and Society - An Indian Perspective	2 0 0	2
15HUM242	The Message of Bhagwad Gita	2 0 0	2
15HUM243	The Message of the Upanishads	2 0 0	2
15HUM244	Understanding Science of Food and Nutrition	1 0 2	2
15JAP230	Proficiency in Japanese Language (Lower)	1 0 2	2
15JAP231	Proficiency in Japanese Language (Higher)	1 0 2	2
15KAN101	Kannada I	1 0 2	2
15KAN111	Kannada II	1 0 2	2
15MAL101	Malayalam I	1 0 2	2
15MAL111	Malayalam II	1 0 2	2
15SAN101	Sanskrit I	1 0 2	2
15SAN111	Sanskrit II	1 0 2	2
15SWK230	Corporate Social Responsibility	2 0 0	2
15SWK231	Workplace Mental Health	2 0 0	2
15TAM101	Tamil I	1 0 2	2
15TAM111	Tamil II	1 0 2	2

Evaluation Pattern

50:50 (Internal: External) (All Theory Courses)

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

80:20 (Internal: External) (Lab courses and Lab based Courses having 1 Theory hour)

Assessment	Internal	External
*Continuous Assessment (CA)	80	
End Semester		20

70:30(Internal: External) (Lab based courses having 2 Theory hours/ Theory and Tutorial)

Theory- 60 Marks; Lab- 40 Marks

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	10	
Continuous Assessment (Lab) (CAL)	40	
End Semester		30

65:35 (Internal: External) (Lab based courses having 3 Theory hours/ Theory andTutorial)

Theory- 70 Marks; Lab- 30 Marks

Assessment	Internal	External
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
Continuous Assessment (Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignment, Projects, and Reports.

Letter Grade	Grade Point	Grade Description
O	10.00	Outstanding
A+	9.50	Excellent
A	9.00	Very Good
B+	8.00	Good
B	7.00	Above Average
C	6.00	Average
P	5.00	Pass
F	0.00	Fail

Grades O to P indicate successful completion of the course

$$CGPA = \frac{\sum (C_i x Gr_i)}{\sum C_i}$$

Where

C_i = Credit for the i^{th} course in any semester

Gr_i= Grade point for the i^{th} course

Cr. = Credits for the Course

Gr. = Grade Obtained

15ENG111 COMMUNICATIVE ENGLISH 2 0 2 3

OBJECTIVES: *To make the students communicate their thoughts, opinions, and ideas freely and naturally; to make them understand the different styles in communication; to make the students understand the aesthetics of reading and writing; to bring in a spirit of enquiry; to motivate critical thinking and analysis; to help them ruminate on human values.*

Unit 1

Reading: Different styles of communication – Reading Comprehension - critical thinking and analysis – Note-making – Any two pieces from the text.

Unit 2

Writing: Prewriting techniques - Kinds of paragraphs - basics of continuous writing.

Grammar & Usage: Parts of Speech, Tenses, Concord, Phrasal Verbs, Modal Auxiliaries, Modifiers (Workbook) - Any two pieces from the text.

Unit 3

Practical sessions (Listening & Speaking): Introduction to English pronunciation including minimal pairs and word stress – differences between British and American English – Listening comprehension and Note-taking - Any two pieces from the text.

Activities: Short speeches, seminars, quizzes, language games, debates, and discussions, Book Reviews, etc.

Text: *Language through Reading: Compilation by Amrita University for internal circulation*

Poems:

i. The Poplar Field by William Cowper
ii. Telephone Conversation by Wole Soyinka

Prose:

i. Higher Mathematics by R. K. Narayan
ii. Wings of Fire by Abdul Kalam (Part III.11)

Short Stories:

i. Best Investment I Ever Made by A. J. Cronin
ii. Death of an Indian by Krishna CharanDas

Language through Practice: Compilation by Amrita University for internal circulation

Outcomes:

CO 1: Demonstrate competency in all the four linguistic skills viz, listening, speaking, reading and writing.

CO 2: Apply different styles of communication in professional context.

CO 3: Take part in different planned & extempore communicative activities.

CO 4: Interpret and Discuss facts and information in a given context.

CO 5: Develop an appreciation for human values.

CO –PO Mapping:

	PO6	PO7	PO8	PO9	PO10	PO12
CO1					3	2
CO2				2	3	2
CO3					3	
CO4					3	
CO5			2			

15MAT111 CALCULUS AND MATRIX ALGEBRA 2 1 0 3

Unit 1

Calculus

Graphs: Functions and their Graphs. Shifting and Scaling of Graphs.

Limit and Continuity: Limit (One-Sided and Two-Sided) of Functions. Continuous Functions, Discontinuities, Monotonic Functions, Infinite Limits and Limit at Infinity.

Unit 2

Differentiation and its Applications: Derivative of a function, non- differentiability, Intermediate Value Property, Mean Value Theorem, Extreme Values of Functions, Monotonic Functions, Concavity and Curve Sketching, Integration: Definite Integrals, The Mean Value Theorem for definite integrals, Fundamental Theorem of Calculus, Integration Techniques.

Unit 3

Matrix Algebra

Review: System of linear Equations, linear independence

Eigen values and Eigen vectors: Definitions and Properties, Positive definite, Negative Definite and Indefinite Matrices, Diagonalization and Orthogonal Diagonalization, Quadratic form, Transformation of Quadratic Form to Principal axes, Symmetric and Skew Symmetric Matrices, Hermitian and Skew Hermitian Matrices and Orthogonal Matrices Iterative Methods for the Solution of Linear Systems, Power Method for Eigen Values and Eigen Vectors.

Outcomes:

CO1: Understand the basic concepts of functions, limits, continuity, derivatives and analyze them.

CO2: Apply the concept of differentiability to find the extreme values of the given function and analyze the derivatives to sketch the graph of the given function.

CO3: Recall the terms, facts and basic concepts of definite integrals and the techniques of obtaining antiderivatives.

CO4: Understand the notion of eigenvalues and eigenvectors, analyze the possibility of diagonalization and hence compute a diagonal matrix, if possible.

CO5: Apply the knowledge of diagonalization to transform the given quadratic form into the principal axes form and analyze the given conic section.

CO6: Understand the advantages of the iterative techniques and apply it to solve the system of

equations and finding eigenvectors.

CO –PO Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO2	1	3	1	-	-	-	-	-	-	-	-	0	-	-
CO3	3	0	0	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	0	-	-	-	-	-	-	-	-	0	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-	0	-	-
CO6	3	0	0	-	-	-	-	-	-	-	-	0	-	-

TEXTBOOKS:

1. *'Calculus', G. B. Thomas Pearson Education, 2009, Eleventh Edition.*
2. *'Advanced Engineering Mathematics', Erwin Kreyszig, John Wiley and Sons, 2015, Tenth Edition.*

REFERENCE BOOKS:

1. *'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rd Edition, 2002.*
2. *'Advanced Engineering Mathematics', by Dennis G. Zill and Michael R. Cullen, second edition, CBS Publishers, 2012.*

15CSE100 COMPUTATIONAL THINKING AND PROBLEM SOLVING 3 0 2 4

Unit 1

Basics: Introduction, Information and data, Data encoding. Logic: Boolean logic, Applications of propositional logic.

Unit 2

Problem Solving and Algorithmic Thinking: Problem definition, Logical reasoning, Problem decomposition, Abstraction. Flowcharting, Name binding, Selection, Repetition, Modularization. Data organization: List and Arrays. Simple algorithms, comparison of performance of algorithms.

Unit 3

Problem Solving Techniques: Factoring and Recursion Techniques, Search and Sort techniques, Text processing and Pattern matching.

Outcomes:

CO1: Apply computational thinking principles and algorithmic building blocks to understand, define, and solve problems
CO2: Design algorithms and implement solutions for problems
CO3: Represent, organize, manipulate and interpret data
CO4: Trace computational states and analyse techniques/ strategies for given solutions

CO-PO Mapping:

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

TEXTBOOKS:

1. *David Riley and Kenny Hunt, Computational Thinking for Modern Solver, Chapman & Hall / CRC, 2014*
2. *R. G. Dromey, "How to solve it by Computer", PHI, 2008*

15CHY100 CHEMISTRY 3 0 0 3

Unit 1

Chemical Bonding

Review of orbital concept and electronic configuration, electrovalency and ionic bond formation, ionic compounds and their properties, lattice energy, solvation enthalpy and solubility of ionic compounds, covalent bond, covalency, orbital theory of covalency - sigma and pi bonds - formation of covalent compounds and their properties. Hybridization and geometry of covalent molecules - VSEPR theory - polar and non-polar covalent bonds, polarization of covalent bond - polarizing power, polarisability of ions and Fajan's rule, dipole moment, percentage ionic character from dipole moment, dipole moment and structure of molecules - co- ordinate covalent compounds and their characteristics, molecular orbital theory for H2, N2, O2 and CO, metallic bond - free electron, valence bond and band theories, weak chemical bonds – inter and intra molecular hydrogen bond - van der Waals forces.

Unit 2

Thermodynamic Parameters

Stoichiometry - mole concept, significance of balanced chemical equation - simple calculations - Conditions for occurrence of chemical reactions - enthalpy, entropy and free changes - spontaneity – Thermochemistry - heats of reactions - (formation, combustion, neutralization) - specific heats - variation of enthalpy change with temperature - Kirchhoff' relation (integrated form) - bond enthalpy and bond order
- Problems based on the above.

Kinetics

Review of molecularity and order of a reaction, rate law expression and rate constant - first, second, third and zero order reactions, pseudo-first order reactions (pseudo-unimolecular reactions) - complex reactions - equilibrium and steady state approximations - mechanism of these reactions - effect of temperature on reaction rates - Arrhenius equation and its significance, Michaelis Menden kinetics-enzyme catalysis.

Unit 3

Electrochemistry

Electrolytes - strong and weak, dilution law, Debye-Huckel theory, faraday's laws, origin of potential, single electrode potential, electrochemical series, electrochemical cells, Nernst equation and its application, reference electrodes - SHE, Ag/AgCl, Calomel.

Photochemistry

Photochemistry, laws of photochemistry - Stark-Einstein law, Beer-Lamberts law, quantum efficiency-determination, photochemical processes - Jablonsky diagram, internal conversion, inter-system crossing, fluorescence, phosphorescence, chemiluminescence and photo sensitization, photo polymerization.

Outcomes:

CO 1: Understand the fundamental concepts of chemistry to predict the structure and properties of engineering materials
CO 2: Develop analytical skills to evaluate the cause, feasibility and course of chemical reactions
CO 3:Design and apply the idea of cutting edge area of chemistry to solve engineering related problems

CO –PO Mapping:

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

REFERENCE BOOKS

Physical chemistry, Puri and Sharma Inorganic chemistry, Puri and Sharma

15PHY100 PHYSICS 3 0 0 3

Unit 1

Review of Classical Physics and dual nature of Waves /particle Review of Kinematics, Force, Newton's Laws, Linear Momentum, Work, Energy, Power, Angular Motion -Kinematics and Mechanics, Angular momentum Torque, Conservation laws (linear and angular).

Particle properties of waves: Photoelectric effect, quantum theory of light, X-ray diffraction, Compton effect, pair production. Wave properties of particles: Waves, De Broglie waves, Group velocity and phase velocity, uncertainty principle.

Unit 2

Atomic Structure and Quantum Mechanics

Atomic Structure: Various models of atom, Atomic Spectra, Energy Levels, Correspondence Principle, Nuclear Motion, Atomic Excitation, and Rutherford Scattering.

Quantum Mechanics: Introduction - wave equation - Schrodinger's equation (time dependent and independent) - expectation values, operators, Eigen value (momentum and energy) – 1D potential box (finite and infinite) - tunnel effect - harmonic oscillator.

Unit 3

Statistical Mechanics and Solid State Physics

Statistical Mechanics: Classical Distribution - Maxwell's Boltzmann-Molecular energies of an ideal gas - most probable speed. Quantum Statistics - Bose-Einstein and Fermi-Dirac. Applications - Black Body Radiation, Specific heat of solids, free electrons in metals, Electron energy.

Solid State Physics: Types of solids, Crystallography, Bonds- Ionics, Covalent, and Van der Waals, Band Theory and energies, Semiconductor Devices, and Superconductivity.

Outcomes:

CO1: Understand, Comprehend and acquaint with concepts of Modern Physics
CO2: Analyze and solve (idealized and quasi practical) physics problems pertaining to various concepts of Modern Physics
CO3: Apply concepts of Modern Physics to solve engineering problems that needs ideas from Modern Physics

CO –PO Mapping:

CO/ PO	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PO13	PSO 1	PSO 2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TEXTBOOK:
"Concept of Modern Physics", Arthur Beiser, Tata-McGraw Hill, edition.

REFERENCE BOOK:
"Principles of Physics" by Halliday, Resnick and Walker, 9th edition

15CHY181 CHEMISTRY LAB. 0 0 2 1

1. Acid base titration (double titration)
2. Complexometric titration (double titration)
3. Redox (permanganimetry) titration (double titration)
4. Conductometric titration
5. Potentiometric titration
6. Ester hydrolysis

Outcomes:

CO1:Develop analytical skills for the determination of water quality parameter

CO2:Understand the electrochemical principles of conductance and electrode potentials and its application in analytical science

CO3:Develop analytical skills in the determination of rates of chemical reactions and its application

CO4:Learn the basics of redox reaction and applying it for quantitative determination.

CO5:Create skills to convert basic chemical reactions to analytical application.

CO –PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
CO1	3	3	1	-	-	-	-	-	-	-	-	-
CO2	3	3	1	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	3	1	-	-	-	-	-	-	-	-	-

15PHY181 PHYSICS LAB. 0 0 2 1

Young's Modulus – Non Uniform Bending Newton's Rings
Laser - Determination of Wavelength and Particle Size Determination Spectrometer
Carey Foster's Bridge

Rigidity Modulus - Tensional Pendulum Viscosity of Liquid by Stokes's method Ultrasonic Interferometer
Hysteresis – B H curve

Outcomes:

CO1: Prepare for the lab experiment and perform individually a wide spectrum of experiments.

CO2: Present experimental data in various appropriate forms like tabulation, and plots.

CO3: Analyze, Interpret and Summarize experimental results.

CO4: Communicate clearly understanding of various experimental principles, instruments/setup, and procedure.

CO –PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3
CO1	-	1	-	-	1	-	-	-	2	1	-	-	-	-	-	-
CO2	-	2	-	2	-	-	-	-	-	-	1	-	-	-	-	-
CO3	-	3	1	-	-	-	-	-	1	1	-	-	-	-	-	-
CO4	-	-	-	-	1	-	1	-	1	3	-	-	-	-	-	-

15MEC180 WORKSHOP A 0 0 2 1

1. **Product Detailing Workshop**

Disassemble the product of sub assembly - Measure various dimensions using measuring instruments - Free hand rough sketch of the assembly and components
- Name of the components and indicate the various materials used - Study the functioning of the assembly and parts - Study the assembly and components
design for compactness, processing, ease of assembly and disassembly - Assemble the product or subassembly.

2. **Pneumatics and PLC Workshop**

Study of pneumatic elements - Design and assembly of simple circuits using basic pneumatic

elements - Design and Assembly of simple circuits using Electro-pneumatics.

Study of PLC and its applications - Simple programming using ladder diagrams.

3. Sheet Metal Workshop

Study of tools and equipments - Draw development drawing of simple objects on sheet metal (cone, cylinder, pyramid, prism, tray etc.) Fabrication of components using small shearing and bending machines - Riveting and painting practice.

4.(a) Welding Workshop

Study of tools and equipments - Study of various welding methods - Arc welding practice and demonstration of gas welding and cutting.

(b) Demo and practice Workshop

Fitting: Study oftools, practice in chipping, filing and making joints. Carpentry: Study of tools, planning practice and making joints

Outcomes:

CO1: Dismantle and assemble various products.

CO2: Design and simulate pneumatic and electro-pneumatic circuits.

CO3: Fabricate sheet metal objects.

CO4: Perform arc welding and soldering.

CO-PO Mapping:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	1	-	-	-	-	-	-	2	1	-	1
CO 2	2	2	1	-	1	-	-	-	2	1	-	1
CO 3	2	2	-	-	-	-	-	-	2	1	-	1
CO 4	2	1	-	-	-	-	-	-	2	1	-	1

REFERENCE:

Concerned Workshop Manual

15EEE180 WORKSHOP B 0 0 2 1

Part A - Electronics

Identification of electronic components (Passive and Active)

Study of measuring instruments (Voltmeter, Ammeter and Multimeter) Measurement and theoretical Verification of series and parallel combination of resistors and capacitors

Calibration of CRO and measurements of signal parameters (RMS, maximum value, peak value, time and frequency)

Calibration of function generator using CRO Soldering practice

Part B - Electrical

1. Study on power supply and protective devices
2. Study on tools and electrical accessories
3. Study on sources of light
4. Study on energy efficiency
5. Study on water pump
6. Study on house hold appliances:

a. Iron box
b. Fan
c. Refrigerator
d. Air conditioner

7. House wiring I – Glow an incandescent lamp using SPST switch
8. House wiring II – Glow a fluorescent lamp using SPST switch
9. House wiring III – Operate a fan and an incandescent lamp using two independent SPST switch
10. House wiring IV – Operate a fluorescent lamp and a 3 pin socket using two independent SPST switch
11. House wiring V – Staircase wiring
12. House wiring VI – Godown wiring

Outcomes:

CO1: Understand electrical safety measures and identify electrical tools, electronic components and their symbols.

CO2: Understand electric laws using simulation studies and detect failures in electrical and electronic circuits.

CO3: Build/Solder and test, residential wiring/Electronic circuits and measure electrical

parameters.

CO4: Estimate the materials required for wiring a building.

CO –PO Mapping:

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

15MEC100 Engineering Drawing CAD I 2 0 2 3
(Pre-Requisite: Nil)

Objectives:

1. To develop drawings using Bureau of Indian Standards (BIS)
2. To communicate effectively through drawings
3. To enhance visualization skills, which will facilitate the understanding of engineering systems.

Keywords:

Coordinate system**,** Orthographic projections, Isometric projections

Contents:

Introduction, Drawing Instruments and their uses, Layout of the Software, standard tool bar/menus, navigational tools. Co-ordinate system and reference planes. Creation of 2 dimensional environment. Selection of drawing size and scale. Commands and Dimensioning.

Orthographic Projections: Introduction, Planes of projection, reference line. Projection of points in all the four quadrants. Projection of straight lines, Projection of Plane Surfaces, and Projection of Solids in first angle projection system.

Outcomes:

CO1: Understand the fundamental principles of first angle and third angle projections.

CO2: Dimension and label the drawings as per standards.

CO3: Construct the drawings by choosing appropriate line type.

CO4: Visualize and construct projections of line and lamina when inclined to one reference plane and both reference planes.

CO5: Visualize and construct solid entities in its simple position and when inclined to one reference plane. CO6: Construct the drawings using computer aided design and drafting software package

CO –PO Mapping:

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

TEXTBOOK:

Bhat N. D. and Panchal V. M, "Engineering Drawing Plane and Solid Geometry" , 42e, Charoatar Publishing House, 2010

REFERENCES:

1. *James D. Bethune, "Engineering Graphics with AutoCAD", Pearson Education, 2014*
2. *K. R. Gopalakrishna, "Engineering Drawing", 2014, Subhas Publications*
3. *Narayan K. L. and Kannaiah P, Engineering Drawing, SciTech Publications, 2003*

15CUL101 CULTURAL EDUCATION I 2 0 0 2

Unit 1

Introduction to Indian Culture; Introduction to Amma's Life and Teachings; Symbols of Indian Culture.

Unit 2

Science and Technology in ancient India; Education in Ancient India; Goals of Life

- Purusharthas; Introduction to Vendanta and Bhagavat Gita.

Unit 3

Introduction to Yoga; Nature and Indian Culture; Values from Indian History; Life and work of Great Seers of India.

Outcomes:

CO1: Be introduced to the foundational concepts of Indian culture and heritage, will be able to understand the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma‟s life a

CO2: Understand the foundational concepts of Indian civilization like purusharthas, law of karma, etc, which contributes towards personality growth.

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

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

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

CO-PO 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	PSO1	PSO 2
CO1	-	-	-	-	-	-	-	2	-	1	-	3	-	-
CO2	-	-	-	-	-	-	1	1	3	2	-	3	-	-
CO3	-	-	-	-	-	-	1	2	3	1	-	3	-	-
CO4	-	-	-	-	-	-	3	3	3	3	-	3	-	-
CO5	-	-	-	-	-	-	1	1	3	3	-	3	-	-

TEXTBOOKS:

1. *The Glory of India (in–house publication)*
2. *The Mother of Sweet Bliss (Amma's Life & Teachings)*

15MAT121 VECTOR CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS 3 1 0 4

Unit 1

Vector Differentiation: Vector and Scalar Functions, Derivatives, Curves, Tangents, Arc Length, Curves in Mechanics, Velocity and Acceleration, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field. (Sections: 9.4, 9.5, 9.6, 9.9, 9.10, 9.11)

Vector Integration: Line Integral, Line Integrals Independent of Path. Green's Theorem in the Plane (Sections: 10.1, 10.2, 10.3, 10.4).

Unit 2

Surface Integral: Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem. (Sections: 10.5, 10.6, 10.7, 10.9)

First Order Differential Equations: First Order ODE, Exact Differential Equations and Integrating Factors (Sections 1.1and 1.4).

Unit 3

Second Order Differential Equations: Homogeneous and non-homogeneous linear differential equations of second order (Review), Modelling: Free Oscillations, Euler-Cauchy Equations, Solution by Undetermined Coefficients, Solution by the Method of Variation of Parameters (Sections 2.1, 2.2, 2.4, 2.5, 2.6, 2.7, 2.10).

System of Order Differential Equations: Basic Concepts and Theory, Constant Coefficient systems – Phase Plane method, Criteria for Critical Points, Stability. (Sections 4.1 – 4.4).

Outcomes:

CO 1: Able to understand, and interpret the concepts.
CO 2: Able to apply the concept and understand them
CO 3: Able to understand and implement the concepts in application oriented problems.
CO 4: Able to understand and analyze the and apply the knowledge of diagonalization of matrices to transform the given quadratic form.
CO5: Able to understand the basic concepts and apply them in modeling the first order ODEs.
CO6: Able to understand and apply methods of undetermined coefficients and variation of parameters to solve second order ODEs.

CO –PO Mapping:

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

TEXTBOOK:

'Advanced Engineering Mathematics', Erwin Kreyszig, John Wiley and Sons, Tenth Edition, 2015.

REFERENCE BOOKS:

1. *'Advanced Engineering Mathematics', Dennis G. Zill and Michael R. Cullen, second edition, CBS Publishers, 2012.*
2. *'Calculus', G. B. Thomas Pearson Education, 2009, Eleventh Edition.*
3. *'Calculus', Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rd Edition, 2002.*

15CSE102 Computer Programming 3 0 0 3

Objectives:

1. The course intends to familiarize the students with the structured programming paradigm.
2. The course aims to provide necessary skills to students to apply the structured programming principles to solve problems

Contents:

Unit 1:

Introduction to C language: Structure of a C program, comments, Data types, variables, constants, data input and output statements, input assertions; expressions and evaluation. Functions: inter function communication, standard functions, scope. Selection: two way selection, multi-way selection. Repetition: concept of loop, loop invariant, pretest and posttest loops, initialization and updating, event and counter controlled loops. Recursion: recursive definition, recurivse solution, designing recursive functions, limitations of recursion.

Unit 2:

Files and streams, file input output, Arrays –1D numeric, searching and sorting, 2D numeric arrays, problems with matrices. Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, arrays of pointers, pointer arithmetic.

Unit 3:

Strings: fixed length and variable length strings, strings and characters, string input, output, array of strings, string manipulation functions, sorting of strings. Enumerated types, Structres: structure vs array comparison, complex structures, structures and functions, Union, binary input output, command line arguments.

Outcomes:

CO1: Understand the structured programming constructs: data types (primitive and compound), control and recursion thereby to understand a given program

CO2: Understand and analyze a given program by tracing, identify coding errors and debug them

CO3: Apply structural programming constructs appropriately for given problem scenarios

CO4: Develop computer programs that implement suitable algorithms for problem scenarios and applications

CO-PO Mapping:

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

TEXTBOOK:

Behrouz A. Forouzan and Richard F. Filberg, "Computer Science A structured programming approach using C", Third Edition, Cengage Learning, 2006.

REFERENCES:

1. *Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language", Second Edition, Prentice Hall, 1988.*
2. *Eric S. Roberts, "Art and science of C", Addison Wesley, 1995.*
3. *Jeri Hanly and Elliot Koffman, "Problem solving and program design in C", Fifth Edition, Addison Wesley (Pearson), 2007.*

15MEC102 ENGINEERING MECHANICS 3 0 0 3

Unit 1

Principles of Statics: Introduction to vector approach - free body diagrams - forces in plane - forces in space - concurrent forces - resolution of forces-equilibrium of particle.

Statics of rigid bodies in two dimension: Moment of a force about a point - moment of a couple - equivalent force - couple system. Rigid body equilibrium: Beams - support reactions.

Unit 2

Friction - block friction, ladder friction. Analysis of trusses - Method of joints, method of sections.

Centroid of lines, areas - composite areas. Second Moment of area - polar moment of inertia - mass moment of inertia - radius of gyration.

Unit 3

Dynamics of particles: Kinematics of particles-rectilinear motion - relative motion - position, velocity and acceleration calculations in cylindrical coordinates.

Dynamics of rigid bodies: General plane motion-translation and rotation of rigid bodies - Chasle's theorem.

CO1	determine rectangular components of a force
CO2	obtain the equivalent force - couple system of a given system
CO3	analyze the equilibrium state of a particle and rigid body
CO4	estimate the moment of inertia of composite area about centroidal or any arbitrary axis
CO5	determine the velocity and acceleration of a particle in rectangular and cylindrical coordinate systems and angular velocity of rigid bodies in general plane motion.

TEXTBOOKS:

1. *Hibbeler, R. C., "Engineering Mechanics - Statics", 12/e, Pearson Education Pvt. Ltd., 2007.*
2. *Beer, F. P. & Johnston, E. R., "Vector Mechanics for Engineers-Statics and Dynamics", 8/ e, McGraw Hill International Book Co., 2008.*

REFERENCES:

1. *Meriam, J. L., "Dynamics", 5/e, John Wiley & sons,2003*
2. *Shames, I. H, "Engineering Mechanics-Statics and Dynamics", 4/e., Prentice-Hall of India Pvt. Ltd., 2003.*
3. *Dubey, N. H. "Engineering Mechanics" McGraw Hill*

15AES111 INTRODUCTION TO AEROSPACE TECHNOLOGY 3 0 0 3

Unit 1

Visual Content (video) about Atmospheric Dynamics and its Influence on Flying Machines – History of Aviation (visual content) – Types of Flying Machines, Major Components of an Aircraft, and their Functions (visual content) – Aircraft vs Rotorcraft (visual content) – Basic Instruments for Flying (visual content) – Physical Properties and Structure of the Atmosphere: Temperature, Pressure and Altitude Relationships.

Unit 2

Newton's Law of Motions Applied to Aeronautics: Evolution of Lift, Drag and Moment – Aerofoils – General Types of Construction: Monocoque and Semi-monocoque – Typical Wing and Fuselage Structure (visual content) – Basic Ideas about Piston, Turboprop and Jet Engines - Use of Propeller and Jets for Thrust Production (visual content) – Stealth Technology: History and Principles.

Unit 3

History of Space flight (visual content) – Major Components of Rocket, Spacecraft and their Functions (visual content) – Principles of Rocket Engines – The Solar System and the

Copernican Model - Kepler's Laws – Orbital Motion – Satellite Orbits - Earth's Outer Atmosphere (visual content).

COURSE OUTCOMES

CO1: Identify the Atmosphere and its levels; Examine effects of the weather on flight.

CO2: Remember the historic attempts at flying; major components of flying machines and aerial navigation.

CO3: Understand Newton's equations of motion of flying vehicles; define various terms: Lift, Drag, Moments, airfoil, monocoque and semimonocoque structures.

CO4: Categorize and subsume thrust production in various types of engines for flight; recognize the principles of Stealth technology.

CO5: Realize the Solar system and its formation; get introduced to MAVs; know the impact of Ptolemic and Copernican systems on planetary motion.

CO6: Apply Kepler's laws of planetary motion; Recognize various orbits; Know Space beyond solar System.

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2					3	3		2	1		3			
CO2	3					2			2	2					
CO3	3	2								2			3	3	3
CO4	3			2			2			3		3	3	3	3
CO5	3					1				2		2	1		
CO6	3	3		2						2		3	3	3	

TEXTBOOK:

Anderson J. D, "Introduction to Flight," 7th edition, McGraw Hill, 2011.

REFERENCES:

1. *Anderson, D. F and Eberhatdt S, "Understanding Flight," 2nd edition, McGraw, 2009.*
2. *Turner M. J, "Rocket and Spacecraft Propulsion," 3rd edition, Springer, 2009.*
3. *Curtis H. D, "Orbital Mechanics for Engineering Students," 3rd edition, Butterworth-Heinemann, 2013.*
4. *Paul A Suhler, "From Rainbow to Gusto: Stealth and the Design of the Lockheed Blackbird," AIAA, 2009.*

15CSE180 Computer Programming Lab. 0 0 2 1

Objectives:

- The laboratory intends to provide hands-on experience on the structured programming paradigm.
- This laboratory facilitates students to apply the structured programming principles to solve problems

Contents:

Solving simple problems with operators, programs on conditional control constructs, programs on loops (while, do-while and for), programs using user-defined functions and library functions, programs on files, arrays (single and multi-dimensional), programs using DMA, programs on strings, structures.

Outcomes:

CO1: Develop solutions for problems systematically using structured logic approach.

CO2: Develop computer programs for a given problem scenario.

CO3: Make use of the programming constructs effectively while developing computer programs.

CO4: Develop modular solutions for a given scenario.

CO-PO Mapping:

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

TEXT BOOKS/REFERENCES:

Behrouz A. ForouzanComputerand ScienceRichardAStructured ProgrammingF.Filberg, Approach"Third Edition, Cengage Learning, 2007.

15CUL111 CULTURAL EDUCATION II 2 0 0 2

Unit 1

1. Relevance of Sri Rama and Sri Krishna in this Scientific Age
2. Lessons from the Epics of India
3. Ramayana & Mahabharata

Unit 2

4. Who is a Wise Man?
5. A Ruler's Dharma
6. The Story of King Shibi

Unit 3

7. Introduction to the Bhagavad Gita
8. Bhagavad Gita – Action without Desire

Unit 4

9. Role and Position of Women in India
10. The Awakening of Universal Motherhood

Unit 5

Patanjali'sAstanga -Yoga System for Personality Refinement

11. Examples of Heroism and Patriotism in Modern India

Outcomes:

CO1: Get an overview of India and her contribution to the world in the field of science and literature
CO2: Understand the foundational concepts of ancient Indian education system and practices associated with them
CO3 : Learn the important concepts of Vedas, Bhagavad-Gita and Yogasutras and their relevance to daily life
CO4 : Familiarize themselves with the inspirational characters and anecdotes from the epics and Indian history
CO5 : Gain a rational understanding of the underlying principles of Indian spirituality

CO-PO Mapping:

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

TEXTBOOKS:

Common Resource Material II (in-house publication)

Sanatana Dharma - The Eternal Truth (A compilation of Amma's teachings on Indian Culture)

15AES201 MECHANICS OF FLUIDS 3 1 0 4

Unit 1

Concept of a Fluid: Continuum, Primary Properties, Compressibility of Fluids, Bulk Modulus, Isothermal & Isentropic Processes, Speed of Sound – Secondary Properties: Viscosity, Newton's Law of Viscosity, Sutherland Equation, Andrade Equation, Surface Tension, Capillarity, Vapor Pressure, Boiling, Cavitation – Hydrostatics: Pascal's Law, Hydrostatic Force on Planar and Non-planar Surfaces, Area Moment of Inertia, Archimedes' Principle, Buoyancy, Stability of Floating Bodies.

Unit 2

Fluid Dynamics: Lagrangian & Eulerian Concepts, Reynolds Transport Theorem, Extensive Property, Intensive Property, Continuity Equation (Differential & Integral Forms) – Conservation of Momentum and Energy: Euler Equation of Motion, Stream Function, Velocity Potential, Bernoulli Equation (Inviscid Steady Flow & Potential Steady Flow) – Laminar Flow: Hagen-Poiseuille Flow, Couette Flow, Plane Poiseuille Flow.

Unit 3

Boundary Layer Development: Boundary Layer Thickness, Displacement Thickness, Momentum Thickness – Momentum Equations: von Karman Momentum Integral Equations (zero pressure gradient), Skin-friction Drag on a Surface – Boundary Layer Equations: Prandtl Boundary Layer Equation and Blasius Solution – Dimensional Analysis: Buckingham Pi-theorem, Method of Repeating Variables – Similitude and Modeling: Modeling Laws, Geometric Similarity, Dynamic Similarity, Kinematic Similarity, Applications.

COURSE OUTCOMES

CO1: Enables to distinguish fluid from solid.

CO2: To understand the stability of floating bodies based on hydrostatic force concept.

CO3: To synthesize conservation principles for mass and momentum for the description of incompressible fluid flow dynamics.

CO4: To characterize the inherent features of boundary layer development associated with real

fluids.

CO5: The relevance of dimensional analysis and modeling in fluid mechanics to formulate pertinent non- dimensional parameters, and its subsequent utilization for the generation of exact models of a given prototype.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1											1			
CO2	3	3		3								1	3		
CO3	3	3		3								1	3		
CO4	3	3		3								1	3		
CO5		3				3						1		1	1

TEXTBOOK:

Bruce R. Munson, Donald F. Young, Theodore H. Okiishi, "Fundamentals of Fluid Mechanics," 4th edition, John Wiley, 2002.

15AES202 INTRODUCTION TO THERMODYNAMICS 2 1 0 3

Unit 1

Review of the Laws of Thermodynamics – Introduction to Engineering Applications of Thermodynamic Equilibrium – Quasi-static Process – Cyclic Process – Work and Heat – Application of First Law for Open and Closed Systems: Typical Work Transfer and Heat Transfer Devices – Perfect Gas – Equation of State - Specific Heats – Real Gas Models – Compressibility Chart – Thermodynamic Properties of Fluids – Pure Substance – Phase-change Process of Pure Substance – P-V-T Surface – SteamTables.

Unit 2

Introduction to the Application of Second Law of Thermodynamics – Heat Engine – Heat Pump

– Refrigerator – Irreversible Processes – Reversible Processes – Carnot Cycle – Carnot Engine – Carnot Theorems – Clausius Inequality – Concept of Entropy and Entropy Change – Introduction to Compressibility and Compressible Flow – Propagation of Sound – Mach number.

Unit 3

Thermodynamic Property Relations: Cyclic Rule, Maxwell Relations, T-D-S Equations – Clausius-Clapeyron Equation – Joule-Thomson coefficient and Inversion Line - Fundamentals of Power cycles: Air Standard Otto and Diesel Cycles, Rankine Cycle, Reversed Carnot Cycle, Brayton Cycle and its Application in Propulsion Systems.

COURSE OUTCOMES

CO1: Understand the law of thermodynamics and various forms of work and energy that can occur.

CO2: Analyze the work and heat interactions associated with a prescribed process path, and to perform a first law analysis of a flow system.

CO3: Apply the understandings of phase change process of pure substances to the flow and non-flow process devices.

CO4: Apply second law of thermodynamics and entropy concepts in analyzing the thermal efficiencies of heat engines and determine the reversibility or irreversibility of a process using change in entropy

CO5: Apply ideal cycle analysis to simple heat engine cycles to estimate thermal efficiency and work as a function of pressures and temperatures at various points in the cycle.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1										3		
CO2	3	3	2	1									3		
CO3	3	3	2	1									3		
CO4	3	3	2	1									3		
CO5	3	3	2	1			1						3	2	

TEXTBOOKS:

1. *Cengel, Y. A. and Boles, M. A., "Thermodynamics: An Engineering Approach," Tata McGraw, 2002.*
2. *Saad, M. A., "Thermodynamics: Principles and Practice," Prentice Hall, New Jersey, 1998.*

REFERENCE:

Borganakke, S. and Wylen V. "Fundamentals of Thermodynamics," Wiley, New York, 2003.

15AES203 MECHANICS OF MATERIALS 2 1 0 3

Unit 1

Stresses in axial members: Normal stress – St. Venant's principle – normal strain – tension and compression test – stress and strain diagrams – factor of safety – Hooke's law. Axial deformation – principle of superposition – lateral strain – Poisson's ratio – shear stress and strain – shear modulus – volumetric strain – bulk modulus – relation between elastic constants. Stresses in joints – shear and bearing stresses – temperature stress and strain – stress concentration.

Unit 2

Stresses in transverse members: Isolation of beam element – intensity of load, shear force and bending moment relation – shear force and bending moment diagrams – bending stresses in transverse members – Euler – Bernoulli' s simple beam theory – bending stress distribution – shear stresses in transverse members – shear stress distribution.

Unit 3

Deflection in transverse members: Moment-curvature relation – double-integration, Macaulay's – conjugate beam – propped cantilever – fixed beams. Stresses in torsional members: Torsional shear stress – torsion equation for circular section – polar moment of inertia – torsional deformation – stresses due to combined loading.

COURSE OUTCOMES

CO1: Analyze the axial members for stress, strain and deformation.

CO2: Know how to draw SF, BM, and HF Diagrams.

CO3: Obtain stresses in beams.

CO4: Estimate the deflection in beams.

CO5: Analyze the torsional members for stress, strain and deformation.

PO/ PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1								2	3	2	
CO2	3	3	2	1								2	3	2	
CO3	3	3	2	1								2	3	2	
CO4	3	3	2	1								2	3	2	
CO5	3	3	2	1								2	3	2	

TEXTBOOK:

James M Gere, Barry J. Goodno "Mechanics of Materials", 8th Edition, Cengage Learning, USA, 2013.

REFERENCES:

1. *Irving H. Shames and James M. Pitarresi, "Introduction to Solid Mechanics" third edition, Prentice-Hall of India Pvt. Ltd. 2006*
2. *Egor P. Popov, "Engineering Mechanics of Solids", Second edition, Prentice-Hall of India Pvt. Ltd., 2004*
3. *S. H. Crandall and N. C. Dahl, "Introduction to Mechanics of Solids", 3rd Edition, Tata McGraw Hill, India, 2013.*
4. *R.C. Hibbeler "Mechanics of Materials", 8th Edition, Pearson Prentice Hall, New Jersey, USA, 2011.*

15AES204 MATERIALS FOR AVIATION AND SPACE 3 0 0 3

Unit 1

Atomic structure, bonding and crystal structure in materials. Imperfections in crystalline solids and their role in influencing materials properties. Mechanical properties: Stress and strain curves for brittle and ductile alloys, elastic, plastic, anelastic, visco-elastic behavior, ductility, resilience, toughness of metals, strengthening mechanisms, grain boundary hardening, solution hardening and work hardening.

Unit 2

Metals and Alloys: Microstructure, properties and applications of ferrous and non-ferrous materials in aviation and space. Solid solutions, solubility limit, phase rule, binary phase diagrams, intermediate phases, intermetallic compounds, recrystallization and grain growth.

Ceramics: Structure, properties and applications of traditional and advanced ceramics for re-entry of space vehicles.

Unit 3

Polymers: Classification of engineering and high performance polymers, additives for engineering and high performance polymers, elastomers. Smart materials and superconductivity, nanomaterials, superalloys. Materials characterization techniques such as, scanning electron microscopy, transmission electron microscopy, atomic force microscopy, differential scanning calorimetry and X-Ray photo electron spectroscopy.

TEXTBOOK:

Cantor B, Assender H, and Grant P (2001), Aerospace Materials, ISBN 07503 0742 0, IOP Publishing Ltd.

COURSE OUTCOMES

CO1: Students have learned thermo-mechanical properties of materials in respect of aviation.

CO2: Students will have clarity on mechanical properties of materials such as steel, aluminum and application to aviation.

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

REFERENCES:

1. *Gauthier M. M. (1995). Engineered Materials Handbook Materials Park, OH: ASM International. [Comprehensive overview on engineering plastics, elastomers, composites, ceramics and ceramic matrix composites.]*
2. *Boyer R., Welsch G., and Collings E. W. (1994). Materials Properties Handbook: Titanium alloys. Materials Park, OH: ASM International. [Extensive coverage of Ti alloy data.]*
3. *Davis J. R. (1997). ASM Speciality Handbook Heat Resistant Materials. Materials Park, OH: ASM International. [Comprehensive overview on superalloys, ferrous and non-ferrous heat-resistant materials.]*

15MAT204 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS **2 1 0 3**

Unit 1

Laplace Transform: Laplace Transforms, Inverse Transforms, Linearity, Shifting, Transforms of Derivatives and Integrals, Differential Equations, Unit Step Function, Second Shifting Theorem, Dirac's Delta Function. Differentiation and Integration of Transforms.

Unit 2

Convolution, Integral Equations, Partial Fractions, Differential Equations, Systems of Differential Equations. (Sections: 6.1 to 6.7)

Fourier Series: Fourier series, Half range Expansions, Parseval's Identity, Fourier Integrals,

Fourier integral theorem. Sine and Cosine Integrals. (Sections: 11.1 - 11.3)

Unit 3

Fourier Transforms: Sine and Cosine Transforms, Properties, Convolution theorem. (Sections: 11.1 -11.3, 11.7-11.9)

Partial Differential Equations: Basic Concepts, Modeling; Vibrating String, Wave Equation, Separation of Variables, Use of Fourier Series, Heat Equation; Solution by Fourier Series. (Sections: 12.1-12.5)

Course Outcomes

15MAT204.CO1	Understand the concepts of Laplace and Fourier transforms and its properties to transform a function from time domain to the frequency domain.
15MAT204.CO2	Obtain the Laplace and Fourier transform and its inverse transform of impulsive, discontinuous and some complicated periodic signals.
15MAT204.CO3	Solve the initial value problems' using Laplace and Fourier transforms on signals arising by changing over to frequency domain.
15MAT204.CO4	Define the Fourier series for periodic functions and determine the Fourier coefficients
15MAT204.CO5	Understand the formation of partial differential equations and apply some standard methods to obtain its solutions.
15MAT204.CO6	Apply Fourier series technique to solve the heat, wave and Laplace equations.

TEXTBOOK:

Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Ninth Edition, 2012.

REFERENCE BOOKS:

1. *Advanced Engineering Mathematics by Dennis G. Zill and Michael R. Cullen, second edition, CBS Publishers, 2012.*
2. *Larry C. Andrews and Bhimson. K. Shivamoggi, The Integral Transforms for Engineers, Spie Press, Washington, 1999.*
3. *J. L. Schiff, The Laplace Transform, Springer, 1999.*

15AES281 MEASUREMENT AND INSTRUMENTATION LAB. 0 0 2 1

Calibration exercises on general purpose test (GPT) equipment such as Oscilloscope, signal generator, and pressure gauges.

Measurement experiments: Displacement using LVDT, velocity using Pitot tube and anemometer, force using Proving ring and load cell, torque using strain gauges, speed using stroboscope and magnetic pickup, and temperature using thermocouple.

Mini Projects: Interdisciplinary in content based on application of course work completed by the student.

COURSE OUTCOMES

CO1: Perform experiments to find out different types of errors and uncertainty in measurements.

CO2: Understand the principle of operation of various measuring instruments used for determining the pressure, force, frequency, linear variation.

CO3: Measure the performance of the instruments with clear understanding of accuracy, repeatability, and resolution.

CO4: Calibrate the instrumentation required for the measurement of pressure, frequency, force, linear variation.

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

15AVP201 /	**AMRITA VALUES PROGRAMME I /**	**1 0 0 1**
15AVP211	**AMRITA VALUES PROGRAMME II**	**1 0 0 1**

Amrita University's Amrita Values Programme (AVP) is a new initiative to give exposure to students about richness and beauty of Indian way of life. India is a country where history, culture, art, aesthetics, cuisine and nature exhibit more diversity than nearly anywhere else in the world.

Amrita Values Programmes emphasize on making students familiar with the rich tapestry of Indian life, culture, arts, science and heritage which has historically drawn people from all over the world.

Students shall have to register for any two of the following courses, one each in the third and the fourth semesters, which may be offered by the respective school during the concerned semester.

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

Message from Amma's Life for the Modern World

Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

Lessons from the Ramayana

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

Lessons from the Mahabharata

Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

Lessons from the Upanishads

Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian

Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, Satyakama Jabala, Aruni, Shvetaketu.

Message of the Bhagavad Gita

Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

Life and Message of Swami Vivekananda

Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

Life and Teachings of Spiritual Masters India

Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi.

Insights into Indian Arts and Literature

The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

Yoga and Meditation

The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

Kerala Mural Art and Painting

Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

Course on Organic Farming and Sustainability

Organic farming is emerging as an important segment of human sustainability and healthy life. Haritamritam' is an attempt to empower the youth with basic skills in tradition of organic farming and to revive the culture of growing vegetables that one consumes, without using chemicals and pesticides. Growth of Agriculture through such positive initiatives will go a long way in nation development. In Amma's words "it is a big step in restoring the lost harmony of nature".

Benefits of Indian Medicinal Systems

Indian medicinal systems are one of the most ancient in the world. Even today society continues to derive enormous benefits from the wealth of knowledge in Ayurveda of which is recognised as a viable and sustainable medicinal tradition. This course will expose students to the fundamental principles and philosophy of Ayurveda and other Indian medicinal traditions.

Traditional Fine Arts of India

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

Science of Worship in India

Indian mode of worship is unique among the world civilisations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realisation of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

Outcomes:

CO1: Appreciate the significance of *Rāmāyaṇa* as an *itihāsa,* and important aspects of *Bālakāṇḍa*.

CO2: Understand the family values and ideal human relationships portrayed in the *Ayodhyakāṇḍa* and *Aranyakāṇḍa* of *Rāmāyaṇa*.

CO3: Understand *dharma* and its nuances, emphasizing its applicability in an individual's life through *Kishkindhakāṇḍa* and *Sundarakāṇḍa* of Ramayana.

CO4: Appreciate the triumph of *dharma* over *adharma* through *Yuddhakāṇḍa*of *Rāmāyaṇa*

CO5: Appreciate the spiritual values from *Rāmāyaṇa* in resolving personal and social conflicts through varied effective presentations of important episodes of the *Rāmāyaṇa*

CO-PO 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	PSO1	PSO2
CO1	-	-	-	-	-	2	2	3	3	3	-	3	-	-
CO2	-	-	-	-	-	3	3	3	3	2	-	3	-	-
CO3	-	-	-	-	-	3	2	3	3	3	-	3	-	-
CO4	-	-	-	-	-	3	-	3	3	3	-	3	-	-
CO5	-	-	-	-	-	3	-	3	3	2	-	3	-	-

15AES211 AERODYNAMICS I 3 0 0 3

Unit 1

Importance of Aerodynamics – Classification and Practical Objectives – Aerodynamic Forces – Moments and their Non-dimensionalization – Airfoil Nomenclature – Airfoil Characteristics.

Unit 2

Complex Functions: Analytic Functions and Cauchy-Riemann Criteria, Conformal Mapping, Joukowski Transformation.

Unit 3

Concept of Circulation – Plane Potential Flow – Laplace Equation – Elementary Flows and its

Superposition – Kutta Condition – Kutta-Joukowski Theorem – Kelvin's Circulation Theorem – Starting Vortex.

COURSE OUTCOMES

CO1: Understand fundamentals and know the non-dimensionalization of aerodynamic forces and moments; familiar with airfoil nomenclature and airfoil characteristics.

CO2: Understand conformal mapping and Jowkowski transformation of airfoil to a circular cylinder.

CO3: Understand plane potential flow and apply to aerodynamic problems of academic and practical interest.

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

TEXTBOOK:

John D Anderson, "Fundamentals of Aerodynamics,"5th edition, McGraw Hill, 2010.

REFERENCES:

1. *E. L. Houghton and P. W. Carpenter, "Aerodynamics for Engineering Students," 5th edition, Butterworth-Heinemann, 2003.*
2. *Milne-Thomson, "Theoretical Aerodynamics," Dover, 1974.*
3. *Krishnamurthy Karamcheti, "Principles of Ideal-Fluid Aerodynamics,"2nd edition, Krieger Pub Co, 1980.*

15AES212 COMPRESSIBLE FLUID FLOW 2 1 0 3

Unit 1

Review of Thermodynamics: Energy Equation - Compressible Flows: Isentropic Flow, Stagnation Properties. Propagation of Sound, Mach number, Distinction between Subsonic and Supersonic flows, the Acoustic Equation, Finite Waves, Formation of Shock waves.

Unit 2

Flow Through Varying-area Ducts – Normal Shock Wave – Oblique Shock Wave – Shock Polar – Shock Wave Interactions – Prandtl-Meyer Expansion – Effect of Back Pressure on Nozzle Flows – Supersonic Wind Tunnels.

Unit 3

Fanno Flow – Rayleigh Flow – Representation of Shock Waves on the T-S Diagram

– Small Perturbation Theory – Similarity Rules – Introduction to the Method of Characteristics.

COURSE OUTCOMES

CO1: Study the formation and analysis of shock waves.

CO2: Analyze expansion waves.

CO3: Learn about compressible flow through CD nozzles.

CO4: Study the impact of friction and heat transfer on compressible flow.

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

TEXTBOOK:

John D Anderson, "Modern Compressible Flow," 3rd edition, McGraw Hill, 2002.

REFERENCES

1. *Shapiro A. H, "The Dynamics and Thermodynamics of Compressible Fluid Flow," Vol.1, Ronald Press Company, 1977.*
2. *Zucker R. D and Biblarz. O, "Fundamentals of Gas Dynamics," 2nd edition, John Wiley, 2002.*

15AES213 AEROSPACE STRUCTURES I 3 0 0 3

Unit 1

Stress at a point, stress transformations, principal stresses, normal and shear strains, strain transformations, principal strains, Mohr's circle, bi-axial and tri-axial stresses, generalized Hooke's law, plane stress and plane strain, analysis of thin and thick walled pressure vessels.

Unit 2

Types of riveted, bolted, and welded joints, merits and demerits of various joints, study of failure behavior and simple design of joints, strain and potential energies, strain energy density, gradually applied loads and suddenly applied loads, Castigliano's theorem I and Castigliano's theorem II, Maxwell-Betti's theorem, unit load method and its applications, principle of virtual work, principle of virtual displacement and principle of virtual force.

Unit 3

Buckling of columns, Euler's formula, effective length, load versus deflection plot, load eccentricity, imperfections, South-well plot, beam columns, maximum principle stress theory, maximum principle strain theory, maximum strain energy theory, maximum shear stress (Tresca) theory, and maximum distortion (von-Mises) theory, loads on an aircraft, characteristics of aircraft structures, basic structural members in aircraft structures and their functions.

COURSE OUTCOMES

CO1: Understand stress and strain transformation on different plane for combined loading

CO2: Use strain transformations to obtain strains from experiments

CO3: Apply the theories of failure to know whether loaded structure is safe or not

CO4: Obtain critical loads for columns with different end conditions

CO5: Able to find changes in compressive stress due to eccentric loading

CO6: Analysis and simple design of various riveted and welded joints

CO7: Apply energy methods to obtain structural deformations

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	2	2								3	3	2	
CO2	3	3	2	2								3	3	2	
CO3	3	3	2	2								3	3	2	
CO4	3	3	2	2								3	3	2	
CO5	3	3	2	2								3	3	2	
CO6	3	3	2	2								3	3	2	
CO7	3	3	2	2								3	3	2	

TEXTBOOKS:

1. *James M Gere, Barry J. Goodno "Mechanics of Materials", 8th Edition, Cengage Learning, USA, 2013.*
2. *R. C. Hibbeler "Mechanics of Materials", 8th Edition, P P Hall, New Jersey, USA, 2011.*

REFERENCES:

1. *James M Gere, Stephen P. Timoshenko "Mechanics of Materials", 2nd Edition, CBS Publishers, New Delhi, 1986.*
2. *Srivastava, Gope " Strength of Materials", Prentice-Hall of India, 2007*
3. *C.T. Sun, "Mechanics of Aircraft Structures", Second Edition, John Wiley & Sons, New York, 2006.*
4. *Megson, T. H. G., "Aircraft Structures for Engineering Students", Butterworth-Heinemann, USA, 2007.*

15AES214 INTRODUCTION TO CONTROL THEORY 2 1 0 3

Unit 1

Mathematical Modeling: Linear Systems, Block Diagrams, Feedback, Input Test Signals, Laplace Transforms. Transfer Functions, State Space Representation.

Unit 2

Definition of Stability – Response vs Pole Locations – Time Domain Specifications – System Type and Steady-State Errors – Routh's Stability Criterion – Root Locus – Guidelines for Sketching – Bode Plot Techniques – Nyquist Criterion – Stability Margins (Gain and Phase).

Unit 3

Root Locus Design Method: Dynamic Compensation (Lead/Lag), PID Controllers – Frequency Response Design Method – Robust Stability and Robust Performance – Introduction to State Space Design, Controllability and Observability – Introduction to State - Feedback and Estimator Design.

COURSE OUTCOMES

CO1: Represent LTI electro-mechanical systems, as a transfer function and state space models

CO2: Obtain time response of first and second order systems

CO3: Determine steady state error performance of a given system

CO4: Ability to use methods like Routh, root locus, Nyquist and Bode plots to analyse a system

CO5: Apply root locus and Bode plots in design of systems

CO6: Apply basic state space design methods

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	1	1	2	1		1	1	1		2	3	3	3
CO2	3	3	2	1	2	1		1	1	1		2	3	3	3
CO3	3	3	2	1	2	1		1	1	1		2	3	3	3
CO4	3	3	2	1	2	1		1	1	1		2	3	3	3
CO5	3	3	3	1	3	1		1	1	1		2	3	3	3
CO6	3	3	3	1	3	1		1	1	1		2	3	3	3

TEXTBOOKS:

1. *R. C. Dorfand R. H. Bishop, "Modern Control Systems," 9th edition, Prentice-Hall, 2001.*
2. *Norman S. Nise, "Control Systems Engineering," 6th edition, Wiley India, 2012.*

REFERENCE:

Ogata, K. "Modern Control Engineering," 5th edition, Prentice Hall, 2010.

15MAT211 CALCULUS OF VARIATIONS AND NUMERICAL METHODS 2 1 0 3

Unit 1

Calculus of Variations: Maxima and minima - The simplest case - Illustrative examples - Natural

boundary conditions and transition conditions – Concept of functional with simple example – Variation of a functional (only necessary conditions) - Simple variational problem - Euler equation - The more general case of variational problems - Constraints and Lagrange multipliers - Variable end points.

Unit 2

Sturm-Liouville problems - Hamilton's principle - Lagrange's equations - Generalized dynamical entities - Constraints in dynamical systems - Applications in dynamics of particles, vibrating string, vibrating membranes, theory of elasticity - The variational problem of a vibrating elastic plate – Direct methods in calculus of variations - The Rayleigh-Ritz and finite difference methods. (Book-1)

Unit 3

Numerical Methods: Solution of Equations by iteration methods. Interpolations.

Numerical Integration and Differentiation. (Book-2: Sections: 19.1-19.5)

COURSE OUTCOMES

15MAT211.CO1	Understand the basic concepts of Calculus of variation
15MAT211.CO2	Gain several techniques to solve different types of variational problems.
15MAT211.CO3	Know the importance of variational problems through some applications.
15MAT211.CO4	Understand the basic concepts of Numerical methods
15MAT211.CO5	Learn multiple methods to get numerical solutions for transcendal and differential equations.
15MAT211.CO6	Gain knowledge about the idea of numerical integration.

TEXTBOOK:

1. *M. Gelfand and S. V. Fomin, Calculus of Variations, Dover Publications, 2000*
2. *Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Ninth Edition, 2012.*

REFERENCE BOOK:

1. *A. S. Gupta, calculus of Variations with Applications, Prentice Hall of India, 1997*
2. *M. K. Venkatraman, Advanced Engineering Mathematics, 2010.*

3. *M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publishers, Fifth ed., 2007.*
4. *Steven Chapra and Raymond Canale, Numerical Methods for Engineers, McGraw Hill, 2007.*

15AES285 MECHANICS OF FLUIDS LAB. 0 0 2 1

Flow Experiments: Calibration of Orificemeter and Venturimeter, V and Rectangular Notches, Pipe Friction, Verification of Bernoulli's Theorem, Reynold's Apparatus, Metacentric Height, Jet Impact Studies.

COURSE OUTCOMES

CO1: Understand the aim of the given experiment along with the underlying theory.

CO2: Setup the experiment and appreciate its limitations.

CO3: Carryout the experiment.

CO4: To draw inferences from the experiments and report the findings.

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

15AES286 MATERIALS TESTING LAB. 0 0 2 1

Tension test on metals, hardness test on metals using the Rockwell and Brinell tests, impact tests on metals using the Charpy and Izod equipments, double shear tests, helical spring tests, static bending and compression tests on wood and deflection test to verify the Maxwell reciprocal theorem.

In addition to the conventional tests, students are assigned to open lab projects that involve experimental studies including fabrication and setting up unconventional testing methods to understand the basic concepts of strength of materials.

COURSE OUTCOMES

CO1: Understand the aim of the experiment (list appended below) along with the underlying theory.

CO2: Setup the experiment and appreciate its limitations.

CO3: Carryout the experiment.

CO4: Record, interpret and report the findings.

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

15SSK221 SOFT SKILLS I 1 0 2 2

CO#	Course Outcomes	Programme Outcomes
1.	Soft Skills: At the end of the course, the students would have developed self- confidence and positive attitude necessary to compete and challenge themselves. They would also be able to analyse and manage their emotions to face real life situations.	PO8, PO9, PO10, PO12
2.	Soft Skills: At the end of the course, the students would hone their presentation skills by understanding the nuances of content creation, effective delivery, use of appropriate body language and the art of overcoming nervousness to create an impact in the minds of a target audience.	PO9, PO10, PO12
3.	Aptitude: At the end of the course, the student will have acquired the ability to analyze, understand and classify questions under arithmetic, algebra and logical reasoning and solve them employing the most suitable methods. They will be able to analyze, compare and arrive at conclusions for data analysis questions.	PO2, PO4
4.	Verbal: At the end of the course, the students will have the ability to dissect polysyllabic words, infer the meaning, inspect, classify, contextualise and use them effectively	PO10, PO12
5.	Verbal: At the end of the course, the students will have the ability to understand the nuances of English grammar and apply them effectively.	PO10, PO12
6.	Verbal: At the end of the course, the students will have the ability to identify, analyse and interpret relationship between words and use the process of elimination to arrive at the answer. They will also have the ability to judge, evaluate, summarise, criticise, present and defend their perceptions convincingly.	PO9, PO10, PO12

CO-PO Mapping:

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

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. Need for change. Fears, stress and competition in the professional world.

Importance of positive attitude, self motivation and continuous knowledge upgradation.

Self-confidence: Characteristics of the person perceived, characteristics of the situation, characteristics of the perceiver. Attitude, values, motivation, emotion management, steps to like yourself, positive mental attitude, assertiveness.

Presentations: Preparations, outlining, hints for efficient practice, last minute tasks, means of effective presentation, language, gestures, posture, facial expressions, professional attire.

Vocabulary building: A brief introduction into the methods and practices of learning vocabulary. Learning how to face questions on antonyms, synonyms, spelling error, analogy, etc. Faulty comparison, wrong form of words and confused words like understanding the nuances of spelling changes and wrong use of words.

Listening skills: The importance of listening in communication and how to listen actively.

Prepositions, articles and punctuation: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving level I: Number system; LCM &HCF; Divisibility test; Surds and indices; Logarithms; Ratio, proportions and variations; Partnership;

Problem solving level II: Time speed and distance; work time problems;

Data interpretation: Numerical data tables; Line graphs; Bar charts and Pie charts; Caselet forms; Mix diagrams; Geometrical diagrams and other forms of data representation.

Logical reasoning: Family tree; Deductions; Logical connectives; Binary logic; Linear arrangements; Circular and complex arrangement; Conditionalities and grouping; Sequencing and scheduling; Selections; Networks; Codes; Cubes; Venn diagram in logical reasoning; Quant based reasoning; Flaw detection; Puzzles; Cryptogrithms.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Quantitative Aptitude by R. S. Aggarwal, S. Chand*
6. *Quantitative Aptitude – Abijith Guha, TMH.*
7. *Quantitative Aptitude for Cat - Arun Sharma. TMH.*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.*
2. *More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources www.the grammarbook.com - online teaching resources*

www.englishpage.com- online teaching resources and other useful websites.

15AES301 AERODYNAMICS II 2 1 0 3

Unit 1

Classical Thin Airfoil Theory for Symmetric and Cambered Airfoils: Lift and Moment Coefficients, Center of Pressure, Predicting Zero Lift Angle of Attack, Flapped Airfoils, Effects of Thickness.

Unit 2

Finite Wing Theory: The Concept of Downwash and Induced Drag – Classical Theorems: Curved Vortex Filament, Biot-Savart Law, Helmholtz's Vortex Theorems – Method of Analysis: Prandtl's Classical Lifting Line Theory, Modern Numerical Lifting Line Method, Lifting Surface Theory, Modern Vortex Lattice Numerical Method.

Unit 3

Flow Physics Associated with Delta Wings: Subsonic Flow Pattern, Pressure Envelope, Leading Edge Vortex Flap (LEVF) Technology and Performance Comparison, Buffeting Phenomena and Types of Vortex Breakdown.

COURSE OUTCOMES

CO1: Understand thin aerofoil theory and extend it to evaluate effects of thickness and flap deflection.

CO2: Understand and apply finite wing theory to evaluate the aerodynamic coefficients and forces for high aspect ratio finite wings

CO3: Understand flow over delta wings and LEVF technology and an introduction to buffeting.

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

TEXTBOOK:

John D Anderson, "Fundamentals of Aerodynamics," 5th edition, McGraw Hill, 2010.

REFERENCE:

E. L. Houghton and P. W. Carpenter, "Aerodynamics for Engineering Students," 5th edition, Butterworth-Heinemann, 2003.

15AES302 AEROSPACE PROPULSION 2 1 0 3

Unit 1

Momentum Analysis of Thrust Generation – Types of Propulsion Systems and their Components – Performance Measures – Propellers: Performance Coefficients – Review ofThermodynamic Cycles - Ideal Cycle Analysis: Ramjets, Turbojets and Turbofan Engines.

Unit 2

Component Performance – Analysis of Real Engines – Chemistry of Combustion – Heat of Combustion – Reaction Rate – Flames – Stability Considerations – Application to Gas Turbine Combustion – Fuels: Properties, Conventional and Modern Aviation Fuels.

Unit 3

Rocket Vehicle Mechanics – Multistaging – Thermodynamics of Rocket Engine – Rocket Engine Performance – Types of Rocket Engines – Fuels for Solid and Liquid Propellant Rockets

– Rocket Cooling.

COURSE OUTCOMES

CO1: Apply momentum conservation laws to the process of propulsive thrust production in various system.

CO2: Analyze propulsion cycle using thermodynamics.

CO3: Study combustion and combustor functioning.

CO4: Comprehend the fundamentals of rocket propulsion.

CO5: Understand the classification of rocket propulsion systems.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1													1	
CO2	1	2	2	1									1	2	2
CO3	2						2							2	
CO4	1														2
CO5	1													2	

TEXTBOOK:

Mattingly.Jack. D, "Elements of Propulsion: Gas Turbines and Rockets," AIAA Education Series, 2006.

REFERENCES:

1. *Turner Martin, "Rocket and Spacecraft Propulsion," 3rd edition, Springer, 2009.*
2. *Mukunda. H. S, "Understanding Combustion," 2nd edition, Macmillan India Limited, 2007.*

15AES303 AEROSPACE STRUCTURES II 3 0 0 3

Unit 1

Introduction to theory of elasticity: equilibrium equations, boundary conditions, constitutive relations, plane stress and plane strain conditions, stress and displacement formulations, strain compatibility relation, governing equations, inverse and semi-inverse methods, Airy's stress function, Torsion in non-circular bars, Prandtl stress function, St. Venant warping function, membrane analogy, torsion in narrow rectangular section.

Unit 2

Euler–Bernoulli and Timoshenko beam theories, bi-directional bending, bending and transverse shear stresses, bending stresses in narrow rectangular section, general symmetric sections, and thin-walled sections, flexural shear flows (FSF), FSF in thin-walled open sections, shear center in open sections.

Unit 3

Torsional shear flows (TSF) in thin-walled open sections, TSF in thin-walled closed sections (single and multiple cells) and warping in open and closed thin-walled sections, FSF in thin-walled closed sections (single and multi-cells) and shear center in closed sections, buckling of non-symmetrical sections and buckling of thin-walled sections.

COURSE OUTCOMES

CO1: Explaining the principles of the Theory of Elasticity approach in solving the engineering problems.

CO2: Implementing the analytical approach to solve the torsional problems.

CO3: Identification of suitable beam theories to understand various stresses developed in thin beams.

CO4: Estimating the warping displacements using the flexural shear flows in thin-walled open sections
subjected to transverse loads.

CO5: Determination of torsional rigidity for thin-walled closed sections under torsional loading.

CO6: Illustrating the concepts of buckling for thin and unsymmetrical sections.

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

TEXTBOOK:

C. T. Sun, "Mechanics of Aircraft structures", John Wiley & sons, New York, 2006.

REFERENCES:

1. *Megson, T. H. G., "Aircraft Structures for Engineering Students", Butterworth-Heinemann, USA, 2007*
2. *Peery, D. J., and Azar, J. J., "Aircraft Structures", 2nd edition, McGraw–Hill, New York, 1993.*
3. *Bruhn. E. H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, 1985.*
4. *Rivello, R. M., "Theory and analysis of flight structures" McGraw-Hill, New York, 1969.*

15AES304 AVIONICS 3 0 0 3

Unit 1

Introduction: Importance and Role of Avionics, the Avionic Environment – Air Data Systems: Air Data Information and its Use, Air Data Laws and Relationships, Air Data Sensors and Computations.

Unit 2

Embedded Systems: Basic Hardware Building Blocks of a Typical Embedded System – Software Concepts Relevant to Avionics: Interrupts and Real Time Operating Systems – Case Studies Illustrating Importance of Embedded Systems in Avionics – Introduction to Electronic Communication Systems – Utility of Radio Navigation Aids.

Unit 3

Inertial Sensors and Systems: Laser and MEMS Gyros, Accelerometers, Attitude Heading Reference System – Navigation Systems: Basic Principles, Inertial Navigation, Strapped-Down Inertial Systems – Introduction to Autopilot and UAV Avionics.

COURSE OUTCOMES

CO1: Explain the importance, subsystems and environmental specifications of Avionics systems

CO2: Derive air data laws and explain its use in air data computer

CO3: Describe working principle of an embedded systems with applications in avionics

CO4: Explain basic elements of electronic communication systems and its applicability to radio navigational aids

CO5: Explain working principle of Inertial sensors like gyros and accelerators and its use in inertial navigation systems

CO6: Explain basic principle of autopilot and UAV systems

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	1										1	3	1	3
CO2	3	1	1									1	3	1	3
CO3	3	1	1									1	3	1	3
CO4	3	1	1									1	3	1	3
CO5	3	1	1									1	3	1	3
CO6	3	1	1									1	3	1	3

TEXTBOOK:

R. P. G Collinson, "Introduction to Avionics", Springer, 2002.

REFERENCES:

1. *Kaytonand Fried, "Avionics Navigation Systems", Wiley, 1997.*
2. *Frank Vahid, Tony Givargis, "Embedded System Design", Wiley, 2006.*

15MAT202 LINEAR ALGEBRA 2 1 0 3

Unit 1

Vector Spaces: Vector spaces - Sub spaces - Linear independence - Basis - Dimension - Inner products - Orthogonality - Orthogonal basis - Gram Schmidt Process.

Unit 2

Change of basis - Orthogonal complements - Projection on subspace - Least Square Principle. Linear Transformations: Positive definite matrices - Matrix norm and condition number – QR – Decomposition

Unit 3

Linear transformation - Relation between matrices and linear transformations - Kernel and range of a linear transformation - Change of basis - Nilpotent transformations - Similarity of linear transformations - Diagonalisation and its applications - Jordan form and rational canonical form.

Outcomes:

CO1: Understand the basic concepts of vector spaces, subspaces, linear independence, span, basis and dimension and analyze such properties on the given set.

CO2: Understand the concept of inner products and apply it to define the notion of length, distance, angle, orthogonality, orthogonal complement, orthogonal projection, orthonormalization and apply these ideas to obtain least square solution.

CO3: Understand the concept of linear transformations, the relation between matrices and linear transformations, kernel, range and apply it to change the basis, to get the QR decomposition, and to transform the given matrix to diagonal/Jordan canonical form.

CO4: Understand the concept of positive definiteness, matrix norm and condition number for a given square matrix.

CO –PO Mapping:

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

TEXTBOOK:

Howard Anton and Chris Rorres, "Elementary Linear Algebra", Tenth Edition, John Wiley & Sons, 2010.

REFERENCES:

1. Gilbert Strang, "Linear Algebra and Its Applications", Fourth Edition, Cengage, 2006.
2. Kenneth Hoffmann and Ray Kunze, Linear Algebra, Second Edition, Prentice Hall, 1971.

15AES381 AERO-STRUCTURES LAB. 0 0 2 1

Determination of principal axis in unsymmetrical bending of beams, experiment on constant strength beam, determination of shear centre location for open and closed sections, testing of beam with combined loading, measurement of vibrations of beams, Wagner beam – Tension field beam experiments, determination of stresses in thin wall cylinder and finding the buckling strength of column using the South well plot test.

In addition to the conventional tests, students are assigned to open lab projects that involve experimental studies including fabrication and setting up unconventional testing methods to understand the basic concepts of thin walled member behavior.

COURSE OUTCOMES

CO1: Understand the aim of the experiments and correlate the results with real time structures.

CO2: Execute the experimental setup and observe the readings for analysis.

CO3: Analyze the experimental results and interpret with theoretical calculations.

CO4: Apply the concepts by doing an open lab experiments and presentation.

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

15AES382 AVIONICS LAB. 0 0 2 1

Control System Exercises using MATLAB / Kits: Open Loop and Closed Loop Responses for Position, Velocity and Température Control Systems.

Mini Projects: Related to Avionics

COURSE OUTCOMES

CO1: Understanding of given open/closed loop control system experiment.

CO2: Ability to setup the experiment in Matlab environment.

CO3: Ability to code in Matlab and carryout the experiment.

CO4: To draw inferences from the Matlab simulations.

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

15SSK321 SOFT SKILLS II 1 0 2 2

CO#	Course Outcomes	Programme Outcomes
1.	Soft Skills: At the end of the course, the students will have the ability to communicate convincingly and negotiate diplomatically while working in a team to arrive at a win-win situation. They would further develop their inter-personal and leadership skills.	PO9, PO10, PO11, PO12
2.	Soft Skills: At the end of the course, the students shall learn to examine the context of a Group Discussion topic and develop new perspectives and ideas through brainstorming and arrive at a consensus.	PO10, PO11, PO12
3.	Aptitude: At the end of the course, students will be able to identify, recall and arrive at appropriate strategies to solve questions on geometry. They will be able to investigate, interpret and select suitable methods to solve questions on arithmetic, probability and combinatorics.	PO2, PO4
4.	Verbal: At the end of the course, the students will have the ability to relate, choose, conclude and determine the usage of right vocabulary.	PO10, PO12
5.	Verbal: At the end of the course, the students will have the ability to utilise prior knowledge of grammar to recognise structural instabilities and modify them.	PO10, PO12
6.	Verbal: At the end of the course, the students will have the ability to comprehend, interpret, deduce and logically categorise words, phrases and sentences. They will also have the ability to theorise, discuss, elaborate, criticise and defend their ideas.	PO9, PO10, PO12

CO-PO Mapping

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

Professional grooming and practices: Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behaviour, personal hygiene, professional attire, cultural adaptability. Introductions and greetings: Rules of the handshake, earning respect, business manners. Telephone etiquette: activities during the conversation, conclude the call, to take a message. Body Language: Components, undesirable body language, desirable body language. Adapting to corporate life: Dealing with people.

Group discussions: Advantages of group discussions, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.

Listening comprehension advanced: Exercise on improving listening skills, grammar basics: Topics like clauses, punctuation, capitalization, number agreement, pronouns, tenses etc.

Reading comprehension advanced: A course on how to approach middle level reading comprehension passages.

Problem solving level III: Money related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics.

Data sufficiency: Concepts and problem solving.

Non-verbal reasoning and simple engineering aptitude: Mirror image; Water image; Paper folding; Paper cutting; Grouping of figures; Figure formation and analysis; Completion of incomplete pattern; Figure matrix; Miscellaneous.

Spacial aptitude: Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems etc., related problems.

TEXTBOOKS:

1. A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman,

London.
2. *Adair. J., (1986),"Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Quick Maths – Tyra.*
6. *Quicker Arithmetic – Ashish Aggarwal*
7. *Test of reasoning for competitive examinations by Thorpe.E. TMH*
8. *Non-verbal reasoning by R. S. Aggarwal, S. Chand*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova*
2. *More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources*

www.the grammarbook.com - online teaching resources
www.englishpage.com- online teaching resources and other useful websites.

15AES390 / 15AES490 LIVE-IN-LAB. 3 cr

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after fourth semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

COURSE OUTCOMES

CO1: Ability to identify a problem, formulate a methodology, analyze, and investigate the results, using acquired theoretical knowledge

CO2: Work as an effective team member.

CO3: Manage the cost and time of the project.

CO4: Ethically communicate the results both orally and as written reports.

CO5: Assess the societal and environment effects of the project.

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

2 1 0 3

15AES311 FINITE ELEMENT METHODS FOR AEROSPACE

Unit 1

Introduction to FEM - equilibrium condition, strain-displacement relation, linear constitutive relations - domain discretization, types of elements, assembly procedures, boundary conditions - Formulations: Potential energy method, Variational formulation, Weighted residual, Galerkin and Rayleigh-Ritz methods.

Unit 2

Coordinate systems, convergence criteria, 1D Elements: Axial elements basic formulations, formations of shape functions, problems using 1D elements, Beam (bending) element: formulations and formation of shape function and problems – 2D elements: Plane stress and Plane strain element formulation, shape function development, problems using 2D elements - axi-symmetric elements - iso-parametric formulation of elements.

Unit 3

3D element formulations - Introduction to FE formulation of Plate bending and shell elements - Numerical integration - Solution techniques of the numerical equations - Introduction to FE software - FE modeling of aircraft and spacecraft components - Application of boundary conditions and loadings on FE models - Analysis of subcomponents like wings, fuselage, motor casing, etc.

COURSE OUTCOMES

CO1: Understand the concepts behind variational methods and weighted residual methods in FEM.

CO2: Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element.

CO3: Develop element characteristic equation procedure and generation of global stiffness equation will be applied.

CO4: Able to apply Suitable boundary conditions to a global structural equation, and reduce it to a solvable form.

CO5: Able to identify how the finite element method expands beyond the structural domain, for problems involving dynamics, heat transfer, and fluid flow.

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

TEXTBOOK:

Daryl L. Logan, "A First Course in the Finite Element Method", CL, New Delhi, 2007.

REFERENCES:

1. *C. S. Krishnamoorthy, "Finite Element Analysis", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1999.*
2. *David V. Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Publishing Company Limited, New Delhi.*
3. *Megson, T. H. G., "An introduction to aircraft structural analysis", Butterworth-Heinemann, USA, 2010.*
4. *Tirupathi R. Chandrapatla and Ashok D. Belegundu, "Introduction to Finite Element in Engineering", Prentice Hall of India, New Delhi.*

15AES312 FLIGHT MECHANICS 2 1 0 3

Unit 1

Equations of Motion – Forces Acting on the Aircraft – Review of Aerodynamic characteristics of the Wing and Compressibility Effects – Review of Propulsion Systems and their Performance Characteristics – Drag Contribution from Aircraft Components – Airplane Performance of Turbojets: Steady Flight, Range, Endurance, Conditions for Maximum Range and Endurance, Climb Performance, Turn Performance, Maximum Load Factor During Turn.

Unit 2

Glide Performance - Take-Off and Landing Performance – Performance of Piston-Props: Steady Flight Climb and Turn Performance, Climb Performance, Turn Performance, Comparison with Turbojets - Turbofan and Turboprop Performance Evaluation Guidelines.

Unit 3

Concept of Static and Dynamic Stability – Longitudinal Stability: Neutral Point, Stick-Fixed and Stick-Free Stability – Longitudinal Control – Hinge Moments – Control Power – Directional Stability and Control – Lateral Stability and Control – Introduction to Dynamic Stability – Stability Derivatives.

COURSE OUTCOMES

CO1: Understand and apply equations of motion for an aircraft. Evaluate performance of turbojet aircrafts for climb, steady flight and turn.

CO2: Glide and take-off and landing performance evaluation. Evaluate the climb, steady flight and turn performance of piston-engine aircrafts

CO3: Able to evaluate longitudinal static stability and understand the principle of dynamic stability

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

TEXTBOOKS:

1. *Hale, Francis J, "Introduction to Aircraft Performance, Selection, and Design". Wiley, 1984.*
2. *Nelson. R. C, "Flight Stability and Automatic Control", 2nd edition, McGraw-Hill, 1998.*

REFERENCES:

1. *Perkins. C. D and Hage. R. E, "Aircraft Performance, Stability and Control", 11th edition, Wiley, 1967.*
2. *Anderson. J. D, "Aircraft Performance and Design", McGraw-Hill, 2010.*
3. *Russel. J. B, "Performance and stability of aircraft", Butterworth-Heinemann, 1996.*

15ENV300 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY 3 0 0 3

Unit 1

State of Environment and Unsustainability, Need for Sustainable Development, Traditional conservation systems in India, People in Environment, Need for an attitudinal change and ethics, Need for Environmental Education, Overview of International Treaties and Conventions, Overview of Legal and Regulatory Frameworks.

Environment: Abiotic and biotic factors, Segments of the Environment, Biogeochemical Cycles, Ecosystems (associations, community adaptations, ecological succession, Food webs, Food chain, ecological pyramids), Types of Ecosystems – Terrestrial ecosystems, Ecosystem Services, Economic value of ecosystem services, Threats to ecosystems and conservation strategies.

Biodiversity: Species, Genetic & Ecosystem Diversity, Origin of life and significance of biodiversity, Value of Biodiversity, Biodiversity at Global, National and Local Levels, India as a Mega-Diversity Nation (Hotspots) & Protected Area Network, Community Biodiversity Registers. Threats to Biodiversity, Red Data book, Rare, Endangered and Endemic Species of India. Conservation of Biodiversity. People's action.

Impacts, causes, effects, control measures, international, legal and regulatory frameworks of: Climate Change, Ozone depletion, Air pollution, Water pollution, Noise pollution, Soil / land degradation / pollution

Unit 2

Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste management.

Discuss the interrelation of environmental issues with social issues such as: Population, Illiteracy, Poverty, Gender equality, Class discrimination, Social impacts of development on the

poor and tribal communities, Conservation movements: people's movements and activism, Indigenous knowledge systems and traditions of conservation.

Unit 3

Common goods and public goods, natural capital / tragedy of commons, Cost benefit analysis of development projects, Environment Impact Assessment (EIA), Environment Management Plan (EMP), Green business, Eco-labeling, Problems and solutions with case studies.

Global and national state of housing and shelter, Urbanization, Effects of unplanned development case studies, Impacts of the building and road construction industry on the environment, Eco-homes / Green buildings, Sustainable communities, Sustainable Cities.

Ethical issues related to resource consumption, Intergenerational ethics, Need for investigation and resolution of the root cause of unsustainability, Traditional value systems of India, Significance of holistic value-based education for true sustainability.

Outcomes:

ENV300.1	CO1: Integrate facts and concepts from ecological, physical and social sciences to characterize some common socio-environmental problems.
ENV300.2	CO2: Develop simple integrated systems and frameworks for solving common interconnected socio-environmental problems.
ENV300.3	CO3: Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
ENV300.4	CO4: Identify the ethical underpinnings of socio-environmental issues in general.

CO-PO Mapping:

CO Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ENV 300.1		1		1		2	3			2		1			
ENV 300.2	1		1				3			2		1			
ENV 300.3							3	2	1	2		1			
ENV 300.4							3	3		2		1			

15AES383 PROPULSION LAB. 0 0 2 1

Euler's Turbomachine Equation – Classification of Turbomachines – Velocity Triangles for Turbines and Compressors – Axial Flow Machines.

Propeller Testing: Estimation of Static Performance, Estimation of Figure of Merit – Nozzle Testing: Mach number Distribution along a Convergent-divergent Nozzle – Flame Speed Measurement: Variation of Flame Speed with Equivalence Ratio – Study of Free Incompressible Jet: Study of Velocity Profiles and the Entrainment Process – Cascade Testing: Measurements of Velocity and Pressure in a Cascade Flow Field: Effect of the Variation in Angle of Attack.

COURSE OUTCOMES

CO1: Conduct the fluid and thermal flow experiments and identify the errors and uncertainties.

CO2: Acquire the understanding of the engineering principles from the different experimental fluid-thermal flow measurements.

CO3: Examine and interpret the experimental results available in the form of tables, graphs, and figures.

CO4: Develop the report from the experimental procedure and outcome of the experiments.

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

TEXTBOOK:

Phillip Hill and Carl Peterson, "Mechanics and Thermodynamics of Propulsion," 2nd edition, Dorling Kindersely (India), 2010.

15AES384 LOW-SPEED AERODYNAMICS LAB. 0 0 2 1

W ind Tunnel Calibration: Velocity Measurements, Boundary Layer Thickness Characterization - Quantification of Level of Turbulence in the Wind Tunnel: Sphere Test – Pressure or Form Drag Measurements: Finite and Infinite Wings, Fuselage, UAV, Locomotives – Flow Visualization: Smoke, Tuft, Surface Coating – Image Processing: Essential Aspects of Image Enhancement Utilizing Commercial Software MATLAB to extract Flow Structures – Open Projects relevant to Aerodynamics.

COURSE OUTCOMES

CO1: Wind Tunnel Calibration that characterizes the quality of flow in the test section.

CO2: Developing valid test models based on dimensional analysis, and model design criteria.

CO3: Qualitative and Quantitative measurements that include flow visualization and image processing, and static pressure distribution with respect to Reynolds number.

CO4: Extracting flow structures, and the form-drag for aircraft configurations, UAV, locomotives and automobiles.

CO5: To execute effectively the aerodynamic optimization for flying or moving machines.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3		3					1	1		1	3	1	1
CO2	3	3	1	3	3				1	1		1	3	3	3
CO3	3	3		3	3				1	1		1	2	3	3
CO4	3	3		3					1	1		1	3	1	3
CO5	3	3	2	3	2		1		1	3		1	3	3	3

15AES385 INNOVATIONS LAB. 0 0 2 1

Identification of Problem – Identification of Criteria and Constraints – Market Study – Brainstorming for Possible Solutions – Generation of Ideas – Exchange of Ideas and Obtaining Feedback from Mentors and Batch-mates – Exploration of Possibilities – Study of Environmental and Social Impact of Innovative Ideas – Convergence on Methodology and Solution to the Problem – Viability for Scaling Up – Build a Model or Prototype – Paper Submissions / Patent Proposals.

COURSE OUTCOMES

CO1: Market survey to identify under-served needs of common people, existing solutions and predict
demand.

CO2: Propose solution (engineering/social) to meet the under-served need.

CO3: Analyze the impact of the proposed solution on environment and society.

CO4: Fabricate prototype with emphasis on industrial design.

CO5: Formulate a business model.

CO6: Ability to convince funding agencies (pitching)

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1				2	2	3			2	3		2	1		1
CO2	2	2	2		2	3			2	2			2		1
CO3	1	1		1	1	3	3	3	2	2		2	2		1
CO4	3	3	3	3	3	2	2	3	3	2		2	2		1
CO5		2			2						3	2			1
CO6									3	3	3	2			1

15SSK331 **SOFT SKILLS III** **1 0 2 2**

CO#	Course Outcomes	Programme Outcomes
1.	Soft Skills: At the end of the course, the students will have the ability to prepare a suitable resume (including video resume). They would also have acquired the necessary skills, abilities and knowledge to present themselves confidently. They would be sure-footed in introducing themselves and facing interviews.	PO9, PO10, PO12
2.	Soft Skills: At the end of the course, the students will have the ability to analyse every question asked by the interviewer, compose correct responses and respond in the right manner to justify and convince the interviewer of one‟s right ca positive attitude and courteous communication.	PO8, PO9, PO10, PO12
3.	Aptitude: At the end of the course, students will be able to interpret, critically analyze and solve logical reasoning questions. They will have acquired the skills to manage time while applying methods to solve questions on arithmetic, algebra, logical reasoning, and statistics and data analysis and arrive at appropriate conclusions.	PO2, PO4
4.	Verbal: At the end of the course, the students will have the ability to understand and use words, idioms and phrases, interpret the meaning of standard expressions and compose sentences using the same.	PO10, PO12
5.	Verbal: At the end of the course, the students will have the ability to decide, conclude, identify and choose the right grammatical construction.	PO10, PO12
6.	Verbal: At the end of the course, the students will have the ability to examine, interpret and investigate arguments, use inductive and deductive reasoning to support, defend, prove or disprove them. They will also have the ability to create, generate and relate facts / ideas / opinions and share / express the same convincingly to the audience/ recipient using their communication skills in English.	PO9, PO10, PO12

CO-PO Mapping:

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

Team work: Value of team work in organisations, definition of a team, why team, elements of leadership, disadvantages of a team, stages of team formation. Group development activities: Orientation, internal problem solving, growth and productivity, evaluation and control. Effective team building: Basics of team building, teamwork parameters, roles, empowerment, communication, effective team working, team effectiveness criteria, common characteristics of effective teams, factors affecting team effectiveness, personal characteristics of members, team structure, team process, team outcomes.

Facing an interview: Foundation in core subject, industry orientation/knowledge about the company
professional personality, communication skills, activities before interview, upon entering interview room, during the interview and at the end. Mock interviews.

Advanced grammar: Topics like parallel construction, dangling modifiers, active and passive voices, etc.

Syllogisms, critical reasoning: A course on verbal reasoning. Listening comprehension advanced: An exercise on improving listening skills.

Reading comprehension advanced: A course on how to approach advanced level of reading, comprehension passages. Exercises on competitive exam questions.

Problem solving level IV: Geometry; Trigonometry; Heights and distances; Co- ordinate geometry; Mensuration.

Specific training: Solving campus recruitment papers, national level and state level competitive examination papers; Speed mathematics; Tackling aptitude problems asked in interview; Techniques to remember (In mathematics). Lateral thinking problems. Quick checking of answers techniques; Techniques on elimination of options, estimating and predicting correct answer; Time management in aptitude tests; Test taking strategies.

TEXTBOOKS:

1. *A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.*
2. *Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.*
3. *Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
4. *The Hard Truth about Soft Skills, by Amazone Publication.*
5. *Data Interpretation by R. S. Aggarwal, S. Chand*
6. *Logical Reasoning and Data Interpretation – Niskit K Sinkha*
7. *Puzzles – Shakuntala Devi*
8. *Puzzles – George J. Summers.*

REFERENCES:

1. *Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.*
2. *More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.*
3. *The BBC and British Council online resources*
4. *Owl Purdue University online teaching resources www.the grammarbook.com - online teaching resources*

www.englishpage.com- online teaching resources and other useful websites.

15AES401 COMPUTATIONAL FLUID DYNAMICS FOR AEROSPACE 2 1 0 3

Unit 1

Introduction to Numerical Methods – Properties of Numerical Solutions: Errors, Consistency, Accuracy, Stability, Convergence, Conservation – Review of Governing Equations of Fluid Dynamics – Review of Classification of PDE's and their Physical Implications for Compressible Flows.

Unit 2

Introduction to the Finite Difference Methods: Discretization of Temporal and Spatial Derivatives,Explicit and Implicit Formulations – Mccormack's Scheme, Extensions to Viscous Flows – Shock Capturing – Lax-Wendroff Method.

Unit 3

Stability Analysis: Von Neumann Stability Criteria, CFL Criterion for Stability – Introduction to Grid Generation: Body Conforming Grids, Algebraic and Elliptic Grids, 2D Unstructured Grids,

C-Grids, O-Grids and H-Grids for Flow Past Airfoils and Wings – Simulation of External and Internal Flows as Applied to Aerospace Components.

COURSE OUTCOMES

CO1: Recall the governing equation of fluid dynamics in conservation and non-conservation form.

CO2: Utilize finite difference method for the discretization of the fluid flow problems.

CO3: Make use of suitable numerical methods for solving the governing equations in the discretized domain by understanding stability sand convergence.

CO4: Choose proper structured / unstructured 2D grids specific to particular fluid flow problems.

CO5: Apply the FDM to develop CFD techniques: Lax-Wendroff , MacCormack techniques.

CO6: Experiment numerically the theoretical understanding of Computational Fluid Dynamics using commercial packages such as Fluent.

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

TEXTBOOK:

John D Anderson, "Computational Fluid Dynamics – The Basics with Application", McGraw Hill, 1995.

REFERENCES:

1. *Tuncer Cebeci, Max Platzer, Hsun Chen, Kuo-Cheng Chang, Jian P. Shao, "Analysis of Low Speed Unsteady Airfoil Flows," Springer, 2005.*
2. *Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, "Computational Fluid Dynamics – A Practical Approach," Elsevier, 2008*

15AES402 AERO-DESIGN 2 2 2 5

Unit 1

Review of Aircrafts and Spacecrafts – Introduction to Design Process: Design Requirements, Data Collection & Statistical Study, Conceptual, Preliminary and Detailed Designs, Regulatory Requirements.

Unit 2

Weight, Volume and Size Estimates: Fixed Wing, Flapping Wing and Rotary Wing Vehicles, Launch Vehicles, Satellites, Lunar and Interplanetary Vehicles, Atmospheric Re-Entry Vehicles, Missiles, Airships, Aerostats and Parachutes – Aerodynamic and Control Surface Design for Atmospheric Vehicles and Space Vehicles – Selection and Design of Propulsion System.

Unit 3

Weight Distribution and Stability Estimates – Estimation of Control Characteristics – Performance Evaluation and Trade-Off Studies – Current Technological and Regulatory Trend Studies – Market Study.

COURSE OUTCOMES

CO1: Able to apply basic aerodynamic, propulsion, structural and flight mechanics concepts to practical design problems and to analyze the effects of design parameters theoretically.

CO2: Appreciate and understand constraints and compromises needed in practical cases.

CO3: Understand issues in various types of flying vehicle design and able to apply basic aerospace concepts for the design of these vehicles

CO4: Able to select and conceptually design Propulsion systems and estimate the weight, volume, shapeand size of aero-vehicles.

CO5: Able to analyze and evaluate weights and stability issues and able to design control surfaces

CO6: Able to appreciate and evaluate a design and conduct trade-off studies and market and

technological trend studies.

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

TEXTBOOK:

Daniel P. Raymer, "Aircraft Design - A Conceptual Approach," 5th edition, AIAA Education Series, 2012.

REFERENCES:

1. *Ajoy Kumar Kundu, "Aircraft Design," Cambridge University Press, 1st Edition, 2010.*
2. *Leeland M Nicolai and Grant E. Carichner, "Fundamentals of Aircraft and Airship Design - Volume I," AIAA, 1st Edition, 2010.*
3. *Leeland M Nicolai and Grant E. Carichner, "Fundamentals of Aircraft and Airship Design - Airship Design & Case Studies - Volume II," AIAA, 1st Edition, 2013.*
4. *Anderson. J. D, "Aircraft Performance and Design", McGraw-Hill, 2010.*

15AES403 FLIGHT DYNAMICS AND CONTROL 3 0 0 3

Unit 1

Review of Static Stability – Concepts and Introduction to Dynamic Stability – Review: Body Axis, Stability Axis, Earth Axis – Euler Angles – Transformation between Axis – Advantages of Axis – Aircraft Equations of Motion – Kinematic Equations.

Unit 2

Small Perturbation Theory: Linear Equations of Motion, Stability Derivatives, Longitudinal and

Lateral Modes – Concept and Physics – Characteristic Equation – Transfer Function Approach – State Space Modeling and Application to Modes.

Unit 3

Flying and Handling Qualities – Autopilots – Stability - Augmentation System (Longitudinal and Lateral Control) – Fly-By-Wire Aircraft – Active Control System – Control Configured Vehicles – Introduction to Relaxed Static Stability – Gust Load Alleviation – Smart Airplanes – Introduction to Digital Control and Stability.

COURSE OUTCOMES

CO1: Explain static and dynamic stability of an aircraft

CO2: Apply 'Small perturbation theory' to derive Linear equations of motion of an aircraft

CO3: Derive stability derivatives using first principles

.

CO4: Understand concept and physics of Longitudinal and lateral Modes

CO5: Derive transfer function of aircraft motion for different control surface inputs

CO6: Recognize the importance of Flying and Handling qualities

CO7: Discuss advanced concepts like stability augmentation system, autopilot and control configured vehicles

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	1	1							1	3	2	2
CO2	2	2	1	1	2							1	3	1	2
CO3	1	2	3	1	2							1	3	3	3
CO4	1	2	3	1	2							1	3	3	1
CO5	2	2	2	1								1	3	2	3
CO6	2	2	3	1	2	2						1	3	3	3
CO7	2	1	3		1	1	1					1	3	3	3

TEXTBOOK:

M. V. Cook, Flight Dynamics Principles, "A Linear Systems Approach to Aircraft Stability and Control," 3rd Edition, Elsevier, 2013.

REFERENCES:

1. *Robert C Nelson, "Introduction to Flight Stability and Automatic Control," 2nd Edition, Mcgraw-Hill, 1998.*
2. *Warren F Philips, "Mechanics of Flight", Wiley, 2004.*

15AES481 UAV LAB. 0 0 2 1

Flight testing using a 3.5 Kg UAV or simulator, to determine following:

Glide performance;
Climb rate;
Range and endurance;
Turn rate;
Short period and Phugoid mode;
Roll subsidence.

COURSE OUTCOMES

CO1:Understand the aim of the given experiment along with the underlying theory.

CO2:Ability to setup the experiment in the flight simulator.

CO3:Carryout the experiment in the Flight Simulator.

CO4:To draw inferences from the experiments and report the findings.

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

15AES495 PROJECT PHASE I **2 cr**

Various project titles based on areas covered up to 7th semester are allotted to batches of 3 to 4 students.

Preliminary studies and investigations on the allotted topic.

COURSE OUTCOMES

CO1: Ability to identify a problem, formulate a methodology, analyze, and investigate the results, using acquired theoretical knowledge.

CO2: Work as an effective team member.

CO3: Manage the cost and time of the project.

CO4: Ethically communicate the results both orally and as written reports.

CO5: Assess the societal and environment effects of the project.

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

15AES499 PROJECT PHASE II 10 cr

To achieve objectives and to carry out detailed investigation towards the outcome of each allotted project.

COURSE OUTCOMES

CO1: Ability to identify a problem, formulate a methodology, analyze, and investigate the results, using acquired theoretical knowledge.

CO2: Work as an effective team member.

CO3: Manage the cost and time of the project.

CO4: Ethically communicate the results both orally and as written reports.

CO5: Assess the societal and environment effects of the project.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2							3	3	2	2
CO2									3	2					3
CO3											3				2
CO4								3		3					2
CO5						3	3								2

ELECTIVES

Elective I

15AES332 FUNDAMENTALS OF HEAT TRANSFER 3 0 0 3

Unit 1

Basic Modes of Heat Transfer: Steady State Calculations with Multiple Modes of Heat Transfer – One-Dimensional Steady State Heat Conduction: Composite Medium, Critical Thickness, Effect of Variation of Thermal Conductivity in Solids, Extended Surfaces – Unsteady State Heat Conduction: Lumped System Analysis – Heat Transfer in Semi-infinite and Infinite Solids - Application of Numerical Techniques.

Unit 2

Fundamentals of Convection: Physical Mechanism, Reynolds Analogy - Free Convection In Vertical Flat Plate – Empirical Relation in Free Convection – Forced Convection – Laminar and Turbulent Convective Heat Transfer Analysis in Flows between Parallel Plates, over Flat Plate and in Circular Pipe – Applications of Numerical Techniques in Problem Solving.

Unit 3

Boiling and Condensation – Radiative Heat Transfer: Introduction to Physical Mechanism, Radiation Properties, Radiation Shape Factors, Heat Exchange between Non-Black Bodies, Radiation Shields. Classification of Heat Exchangers – Temperature Distribution – Overall Heat Transfer Coefficient – Heat Transfer in Gas Turbine Combustion Chambers, Rocket Thrust Chambers and Cryogenic Systems.

COURSE OUTCOMES

CO1: Understanding the basics of three modes of heat transfer and their fundamentals, namely conduction, convection and radiation.

CO2: Apply the conduction fundamentals to obtain solutions for steady/unsteady state heat conduction problems like heat transfer through solids slabs, extended surfaces, semi-infinite and infinite solids.

CO3: Know the parameters influencing the convection heat transfer and reason for the usage of the Empirical/ semi-empirical correlations.

CO4: Apply the convection fundamentals to obtain solutions Free & Forced convections problems flowbetween the parallel plates, over the flat plates and circular pipes.

CO5: Analyze heat transfer problems involving both conduction and convection.

CO6: Understand the properties of radiation, physical mechanism, shape factors and radiation shields.

CO7: Analyze radiation heat transfer problems given the necessary functional inputs

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	1									2	3	1	1
CO2	3	3	2	2	1							2	3	2	1
CO3	3	2	1									1	3	1	1
CO4	3	3	2	2	1							2	3	2	1
CO5	3	3	3	2	1							2	3	2	1
CO6	3	2	1									2	3	1	1
CO7	3	2	1									2	3	1	1

TEXTBOOK:

Incropera. F. P. and Dewitt. D. P., "Fundamentals of Heat and Mass Transfer," 5th edition, John Wiley

and Sons, New York, 2002.

REFERENCES:

1. *Yunus A. Cengel., "Heat Transfer – A practical approach," 2nd edition, Tata McGraw-Hill, 2002*
2. *Holman. J. P., "Heat Transfer," 6th edition, McGraw-Hill, New York, 1991.*
3. *Sutton. G. P., "Rocket Propulsion Elements," 5thedition, John Wiley and Sons, New York, 1986.*

15AES352 VIBRATION ANALYSIS 3 0 0 3

Unit 1

Introduction to vibration, undamped vibration, natural frequency, damped vibration, viscous damped system, under, over and critically damped system, logarithmic decrement, Coulomb damping, response to initial condition, response to simple harmonic motion, rotating unbalance, base excitation, whirling of shafts, vibration measuring instruments, response to periodic motion.

Unit 2

Response to non-periodic motions, impulse response, step response, convolution and Du Hamel integrals, Numerical methods: Runge-Kutta method, Normal mode analysis, response to initial conditions, beat phenomenon, response to simple harmonic motion, damped vibration, static and dynamic coupling, principle coordinate, decoupling, Rayleigh's proportionality damping, vibration absorber.

Unit 3

Modeling of multi-degree freedom system, stiffness and flexibility influence coefficients, modeling of beam and portal members, response to periodic and non-periodic motions, modal analysis (mode – synthesis method), Vibration of continuous: Free vibration of string, bar, shaft and beam.

COURSE OUTCOMES

CO1: Derive equation of motion for systems under translational and rotational motions.

CO2: Know how to obtain response to Initial conditions or forced excitations.

CO3: Derive equations of motion for MDOF systems and obtain normal modes.

CO4: Know how to obtain response of MDOF systems for any excitations.

CO5: Derive equation of motion for continuous (1D) systems and obtain natural frequencies and normalmodes.

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

TEXTBOOK:

W. T. Thomson, "Theory of vibrations with applications," Pearson, 1997.

REFERENCES:

1. *Leonard Meirovitch, "Elements of vibration Analysis," Tata McGraw Hill, 1986.*
2. *Leonard Meirovitch, "Fundamentals of vibration," McGraw Hill, 2001.*
3. *S. S. Rao, "Mechanical vibrations," Pearson, 2010.*

15AES372 MANUFACTURING PROCESSES 3 0 0 3

Unit 1

Introduction to casting, rolling, forging, extrusion, drawing and sheet metal working-types of defects and remedies.

Unit 2

Introduction to welding and their types, Welding defects: causes and remedies. Rivet and it types. Definition and concept – production of metal powders - characteristics of metal powders - compaction - sintering – design consideration - process capability - applications.

Unit 3

Abrasive jet machining, ultrasonic machining, Electro-discharge machining, electrochemical machining and laser beam machining. Surface modification processes - diffusion coating – electroplating –

anodizing - conversion coating - hot dipping - ceramic and diamond coating.

Rapid Prototyping & Its types, CNC and Types of CNC's.

COURSE OUTCOMES

CO1: Recalling the material triad and to know about materials used in aerospace industries.

CO2: Understanding the fundamentals of casting and rolling, traditional processes and process used in aerospace Industries.

CO3: Understanding fundamentals of welding and Riveting, traditional processes and process usedin aerospace Industries.

CO4: Understanding the concept of powder metallurgy and its process.

CO5: Understanding unconventional machining process, Rapid prototyping and surface modification process.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3		2									3	3		2
CO2	3		2									3	3		2
CO3	3		2									3	3		2
CO4	3		2									3	3		2
CO5	3		2									3	3		2

TEXTBOOK:

F. C. Campbell, "Manufacturing Technology for Aerospace Structural materials", Elsevier Science Ltd; 1 edition (15 August 2006)

REFERENCES:

1. Serope Kalpakjian and Steven R. Schmid, 'Manufacturing Engineering and Technology', Pearson Education Asia, 2000 (fourth ed.) (Indian Reprint 2000).
2. P. K. Mishra, 'Nonconventional Machining process', Narosa Publishing House, 2006.
3. A. Azad, 'Fundamentals of Computer Aided Manufacturing', Jaico Publishing House, 2006.

Elective II

15AES342 EXPERIMENTAL AERODYNAMICS 3 0 0 3

Unit 1

Examples of Fluid Mechanics Measurements: Wind-Tunnel Studies, Turbulent Mixing Layer, Spatial and Temporal Resolution in Measurements, Classification of Deterministic Data, Random Data, Signal Analysis and Uncertainty Analysis.

Unit 2

Qualitative Characterization: Flow Visualization in Liquid and Gaseous Medium, Colored Filament, Smoke, Vapor and Tufts Visualization, Image Processing Techniques, Identifying Structures - Optical Systems for Flow Measurement: Shadowgraph, Schlieren and Interferometric Techniques.

Unit 3

Quantitative Characterization: Drag Measurements, Static Probes, Pressure Sensitive Paints (PSP), Velocity Measurements, Pitot-Static Probe, Theromocouple, Thermal Anemometers (Hot Wire and Film Sensors), Laser Velocimetry (LDA), Particle Image Velocimetry (PIV).

COURSE OUTCOMES

CO1: Understand and appreciate the fundamentals of measurements and turbulence in experimental aerodynamics.

CO2: Know the various flow visualization techniques and their applications for different scenarios

CO3: Understand various velocimetry techniques and instrumentation.

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

TEXTBOOK:

Cameron Tropea, Alexander L Yarin, John F Foss, "Springer Handbook of Experimental Fluid

Mechanics," Springer, 2007.

REFERENCES:

1. *Richard J Goldstein, "Fluid Mechanics Measurements," 2nd edition, Taylor & Francis, 1996.*
2. *Wolfgang Merzkirch, "Flow Visualization," Academic Press, 1974.*

15AES353 COMPOSITE MATERIALS AND MECHANICS 3 0 0 3

Unit 1

Introduction to Composites: Concept of Composite materials, Classification of Composites, Various types of composites, Classification-based on Matrix Material: Organic Matrix Composites (Polymer matrix composites (PMC) / Carbon Matrix Composites or Carbon-Carbon Composites, Advantages of Composites materials. Reinforcements and Matrices for various types of composites Fibers / Reinforcement Materials, Role and Selection of reinforcement materials, Types of fibers, Mechanical properties of fibers,

Unit 2

Functions of Matrix, Desired Properties of Thermosets and Thermoplastics, Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Laminated composites, Lamina and Laminate Lay-up, Ply-orientation definition, Manufacturing processes. Testing of Composites:Mechanical testing of composites, Tensile testing, Compressive testing.

Unit 3

Determination of longitudinal and transverse strengths of lamina, mechanics of short fiber composites, stress-strain relationships of anisotropic lamina with arbitrary orientations, analysis of laminated composites, types of laminates, stress-strain variation in laminates using classical lamination theory, thermal stresses in laminates, different types of failure criteria, introduction to inter-laminar stresses in composites.

COURSE OUTCOMES

CO1: Identify and explain the types of composite and their salient feature.

CO2: Understand the differences in the strengthening mechanism of composite and its corresponding effect on performance and application.

CO3: Understand and apply the methods employed in composite fabrication.

CO4: Appreciate the theoretical basis of the experimental techniques utilized for failure mode of composites.

CO5: Develop expertise on the applicable engineering design of composite.

CO6: Learn simple micromechanics and failure modes of composites.

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

TEXTBOOK:

Jones R. M., "Mechanics of Composite Materials", Hemisphere Publishing Corporation, New York

REFERENCES:

1. *Agarwal B. D. and Broutmen L. J. "Analysis and performance of Fiber Composites", John Wiley and Sons, New York 1990.*
2. *Chawla, Krishan K (2012), Composite Materials, Science and Engineering, ISBN: 978-0-387-74365, Springer.*
3. *Sam Zhang, Dongliang Zhao (2013), Aerospace Materials Handbook, ISBN: 978-1-4398-7329-8, Taylor and Francis.*
4. *Leonard Hollaway (1994), Handbook of Polymer Composite for Engineers, ISBN: 1-85573-1290, Woodhead Publishing Ltd.*

15AES373 ADVANCED AVIONICS 3 0 0 3

(Prerequisite - 15AES304AVIONICS or equivalent)

Unit 1

Electromagnetic Wave Propagation and its Relevance to Aviation – Electronic Communication Systems: Functional Description of Basic Building Blocks, Antenna, Amplifier, Filter, Modulator and Demodulator – Introduction to Digital Communication and Telemetry.

Unit 2

System Level Description of Radio Navigation Aids: Instrument Landing System, Very High Frequency Omni Range, Automatic Direction Finder, Distance Measuring Equipment, GPS, Radar, Traffic Alert and Collision Avoidance.

Unit 3

Autopilots and Flight Management System: Autopilots, Flight Management Systems – Avionic System Integration: Background, Data Bus Systems, Integrated Modular Avionics.

COURSE OUTCOMES

CO1: Basic understanding of electronic communication system

CO2: Explain digital communication blocks and its application in telemetry

CO3: Understand the operating principles of electronic navigation aids

CO4: Understand working principles of Autopilots and Flight management systems

CO5: Explain data bus used in aircraft and its utility in realising modular avionics

CO6: Understand working principle of basic blocks in a typical UAV

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

TEXTBOOKS:

1. *R. P. G Collinson, "Introduction to Avionics", Springer, 2002.*
2. *Frenzel Louis, "Principles of Electronic Communication Systems", 4th Edition, McGraw-Hill, 2015.*

REFERENCES:

1. *Kaytonand Fried, "Avionics Navigation Systems", 2nd edition, Wiley, 1997.*
2. *Dale R. Cundy, Rick S. Brown, "Introduction to Avionics", Prentice Hall, 1997.*

Elective III

15AES432 AIR BREATHING ENGINES 3 0 0 3

Unit 1

Review of Cycle Analysis of Air-Breathing Engines – Application of Euler's Turbo Machinery Equation to Axial and Centrifugal Machines: Velocity Diagrams, Stage Parameters, Three Dimensional Flows in Turbo-Machinery – Components of Axial and Centrifugal Turbines – Performance Maps – Compressor Turbine Matching – Surge Control.

Unit 2

Thermal Limits of Blades and Vanes – Blade Cooling, Film Cooling and Regenerative Cooling – Subsonic, Supersonic and Hypersonic Inlets – Inlet Sizing – Inlet Performance – The Combustion Process: Stability, Length Scaling.

Unit 3

Fuels – Types of Combustors – Combustor Performance – Afterburners – Flame Stabilization – Nozzles, Thrust Vectoring – Nozzle Performance.

COURSE OUTCOMES

CO1: Study momentum transfer through turbomachines.

CO2: Review concepts of Propulsion engine cycle.

CO3: Analyze design and performance of axial flow turbo machines.

CO4: Analyze flow through centrifugal compressors.

CO5: Learn parameters that govern combustor design.

CO6: Analyze flows through intakes and nozzles.

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

TEXTBOOK:

Mattingly. Jack. D, "Elements of Propulsion: Gas Turbines and Rockets," AIAA Education Series, 2006.

REFERENCES:

1. Flack. R. L, "Fundamentals of Jet Propulsion with Applications," Cambridge University Press, 2005.

2. Hill and Peterson, "Mechanics and Thermodynamics of Propulsion," Dorling Kindersely (India), 2010.

15AES452 ENGINEERING FRACTURE MECHANICS 3 0 0 3

Unit 1

Introduction to fracture mechanics (FM), historical development of FM-Linear and elasto-plastic fracture mechanics introduction, modes of loading, crack growth on fracture mechanics, brittle failure and ductile failure concept study. Study on energy release rate, review of theory of elasticity, Airy's stress theory on 2D models. Double cantilever beam energy release rate (ERR) definition, Energy release rate derivation on different geometries, ERR based on displacement of crack faces mechanisms, Necessary and sufficient condition of FM and stable and unstable FM.

Unit 2

Stress field analysis – different approaches to predict stresses, displacement formulation, compatibility conditions, principal of superposition. Crack-tip stress and displacement field - Cauchy-Riemann conditions, Westergaard's stress function, stress intensity factors derivations. Crack opening displacement (CTOD/COD), very near-tip displacement field (Mode - I, II, III), multi-parameter stress field, K for different load conditions. Crack opening displacement (CTOD/COD).

Unit 3

Energy release rate by J-integral approach, relation study between K and G. Study of surface cracks, stress intensity factor study on finite body Evaluation of SIF by experimental and numerical approaches and also using strain gauges. Fracture toughness tests – plane strain test, Compact tension test, three-point bending test, C-specimen test, Chevron notch test

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COURSE OUTCOMES

CO1: Illustrate the types of fractures with characteristic features and growth mechanisms in practical applications.

CO2: Understanding the principles of energy release rate and determining the energy release rate ondifferent geometries.

CO3: Introducing the concepts of stress intensity factor (SIF) and calculation of stress intensity factor fordifferent failure modes.

CO4: Deriving the toughness parameter for various crack models using SIF and finding the cracked Configuration using the crack tip opening displacement (CTOD) method.

CO5: Study of J-Integral approach to determine the crack propagation.

CO6: Identifying the various procedures to find the critical stress intensity factors and evaluate the stress intensity factors for surface and internal cracks.

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

TEXTBOOK:

Anderson, T. L., "Fracture Mechanics", 2nd Edition, CRC Press, 1995.

REFERENCES:

1. *Ramesh, K., "e-book on Engineering Fracture Mechanics", IIT-Madras publisher.*
2, *Prashant Kumar, "Elements of Fracture Mechanics" Tata McGraw-Hill Education, 2009.*

15AES462 HELICOPTER THEORY 3 0 0 3

Unit 1

Historical development, configurations of helicopters, rotor system, flight control and mechanism, hovering theory, momentum theory for hover and vertical flight, blade element theory for hover and vertical flight, combined blade element momentum (BEM) theory.

Unit 2

Momentum theory for forward flight, various non-uniform inflow models, blade element theory for forward flight, non-dimensional hub forces and moments, estimation of power for forward flight.

Unit 3

Idealization of rotor blades, flap-lag and torsional dynamics of the blade, rotor blade flapping motion: A simple model, helicopter trim analysis.

COURSE OUTCOMES

CO1: Estimate the performance of a helicopter using momentum theory.

CO2: Understand the blade element theory for hover and vertical flight.

CO3: Understand the blade element momentum theory for forward flight.

CO4: Analyze the blade response and trim condition of a helicopter rotor system.

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

TEXTBOOK:

C. Venkatesan, "Fundamentals of helicopter dynamics," CRC Press, 2015

REFERENCES:

1. *W. Johnson, "Helicopter theory", Princeton University, 1980.*
2. *R. S. Bramwell, "Helicopter dynamics", Edward Arnold Publications, 1976*

Elective IV

15AES430 ROCKET AND SPACECRAFT PROPULSION 3 0 0 3

(Prerequisite AES212 COMPRESSED FLUID FLOW or equivalent)

Unit 1

Principle of Rocket Propulsion – Rocket Equation – Development of Thrust – Nozzle Design – Effect of Atmosphere – Thermodynamic Thrust Equation – Characteristic Velocity – Performance Parameters.

Unit 2

Liquid Propellant Rocket Engine – Cryogenic and Semi-cryogenic Engines – Basic Configuration – Types of Propellants – Propellant Feed Systems – Combustion of Liquid Propellants – Injectors and Thrust Chambers – Combustion Instability – Solid Propellant Fundamentals –Types of Solid Propellants – Propellant Processing and Manufacture – Grain Configuration – Igniter Hardware – Combustion of Solid Propellants – Hybrid Rocket Engines.

Unit 3

Electric Propulsion: Electrothermal and Electromagnetic Thrusters, Applications of Electric Propulsion, Electric Power Generation – Nuclear Propulsion – Operational Issues – Practical Approaches for Single Stage to Orbit Vehicles.

COURSE OUTCOMES

CO1: Recall the operating principle of the rocket and spacecraft propulsion systems.

CO2: Develop the expressions for the performance parameters such as thrust, specific impulse, thrust coefficient, characteristic velocity, etc.,

CO3: Interpret the influence of atmospheric conditions on the performance parameters of the rocket and spacecraft propulsion systems.

CO4: Distinguish solid rocket motor, liquid propellant rocket, and hybrid rocket motor in terms of general characteristics, propellant properties with its relative advantages and disadvantages.

CO5: Demonstrate the working principle with relative advantages and disadvantages of advanced propulsion systems such as electric propulsion and nuclear propulsion

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

TEXTBOOKS:

1. Truner. Martin, "Rocket and Spacecraft Propulsion," 3rd edition, Springer, 2009.

2. Sutton. G. P, Biblarz. O, "Elements of rocket propulsion," 7th edition, John Wiley & Sons Inc, 2010.

15AES442 HYPERSONIC FLOW THEORY 3 0 0 3

Unit 1

Introduction – Basic Considerations and Definitions – Videos of Atmospheric Re-Entry – Thin Shock Layer – Entropy Layer – Viscous Interaction – Low Density Flows – High Temperature Effects – Visual Presentation of Damages due to High Temperature Effects – Hypersonic Flight Paths.

Unit 2

Inviscid Hypersonic Flow Theory: Shock Expansion Method, Surface Inclination Methods – Small Disturbance Equations and Approximate Methods – Similarity Laws.

Unit 3

Exact Methods – Method of Characteristics Review – Unit Processes for Method of Characteristics: Planar, Axisymmetric and 3-D Flows – Blunt Body Problem and Shock Interaction Types – Modern Computational Methods – Introduction to Viscous Hypersonic Flows.

COURSE OUTCOMES

CO1: Identify the critical flow physics phenomenon influencing hypersonic and planetary re-entry flows.

CO2: Explain the recent developments in hypersonic flow theory with application to Aerospace Systems.

CO3: Utilize Shock-Expansion theory, Surface inclination method, and Newtonian theory for the estimation of pressure distribution of simple shapes.

CO4: Formulate and solve the problems involving inviscid hypersonic flow over blunt bodies.

CO5: Interpret the influence of viscous effects in the hypersonic flow over simple shapes.

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

TEXTBOOK:

John D. Anderson, "Hypersonic and High Temperature Gas Dynamics," McGraw Hill, 2002.

REFERENCE:

Wallace D. Hayes and Ronald F. Probstein, "Hypersonic Flow Theory," 2nd edition, Academic Press, 1959.

15AES453 AERO-ELASTICITY 3 0 0 3

Unit 1

Free vibration analysis of basic structural members with different boundary conditions, analytical and approximate solutions, response of basic structural members to periodic and non-periodic forces, mode synthesis, approximate solutions.

Unit 2

Static aero-elasticity, divergence of a typical airfoil section, aileron reversal, divergence of one dimensional structures: straight and swept wings, aileron reversal of one dimensional straight wing.

Unit 3

Aeroelastic flutter, stability characteristics, aeroelastic analysis of a typical airfoil section: single degree and two degree freedom, classical flutter analysis, classical unsteady aerodynamic theory, engineering solution for flutter, U-g and p-k methods, response to gust loads.

COURSE OUTCOMES

CO1: Know how to obtain equations of motion for MDOF systems using influence coefficients.

CO2: Obtain response to a force for continuous systems.

CO3: Understand divergence and aileron effeteness of a wing.

CO4: Understand flutter phenomena of a wing.

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

TEXTBOOK:

Dewey H. Hodges, and G. Alvin Pierce, "Introduction to structural dynamics and aeroelasticity," Cambridge University Press, 2002

REFERENCES:

1. Raymond L. Bisplingoff, Holt Ashley, Robert L. Haffman.,"Aeroelasticity", Dover Publications,1996.

2. Raymond L. Bisplingoff, Holt Ashley, "Principles of Aeroelasticity", Dover Publications, 2002.

15AES454 ADVANCED COMPOSITE STRUCTURES 3 0 0 3

Unit 1

Concept of aviation and space environments. Ionizing and non ionizing radiation at Low Earth Orbit (LEO) and Geo Synchronous Earth Orbit (GEO). Charged plasma and atomic oxygen in space. Different thermosetting and thermoplastic polymers and their applications as structural and semi structural components for aviation and spacecraft.

Unit 2

Durability of thermosetting and thermoplastic polymers under aviation and space environments. Scope of high performance polymers. Scope of high performance and ultra high performance polymers. Defects of composites under mechanical fatigue, thermal fatigue, humidity, lightening strike, ultra violet radiation, ultra high vacuum and high energy radiations.

Unit 3

Simulation of test facilities in laboratory. State of the art technologies to repair composite defects. Importance of nano composite and nano adhesive bonding. Importance of fire resistant polymeric composites and electrically conductive composites.

COURSE OUTCOMES

CO1: Demonstrate understanding of fundamentals in materials, manufacturing, mechanics, design, and repair of polymeric matrix composites.

CO2: Identify advantages and disadvantages of polymeric matrix composites with respect to metals.

CO3: Apply the knowledge acquired to the design and manufacturing of high-performance composite Structures.

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

TEXTBOOK:

Omari V. Mukbaniani, Marc J. M. Abadie, Tamara Tatrishvili (2015), High-Performance Polymers for

Engineering-Based Composites, ISBN 9781771881197 - CAT# N11265, CRC Press.

REFERENCES:

1. *Yu Bai, Thomas Keller (2014), High Temperature Performance of Polymer Composites, ISBN: 978-3-527-32793-5, Wiley-VCH.*
2. *Eric Baer (1991), High Performance Polymers: Structures, Properties, Composites, Fibers, ISBN-13: 978-1569900024, Amazon Prime*

15AES470 STATE SPACE TECHNIQUES 3 0 0 3

Unit 1

Concepts of Matrix Algebra and Vector Spaces (revision) – Solution of Simultaneous Equation for Squares – Under-Determined and Over-Determined Systems – Concepts of Basis Vector Transformations; Similarity and Adjoint Transformation – Eigen Values and Eigen Vectors:Canonical Forms, Jordon Forms, Characteristic Equations, Analytical Functions of Square Matrices, Cayley-Hamilton Theorem.

Unit 2

Concepts of State, State-Space and State-Vector – Mathematical Modes in the State Space Form – State Equation and High-Order Differential Equations – State Space Form for Aerospace Systems, for e.g., Dynamic Behavior of Aircraft, Missile, Satellites, INS., etc. – Solution of Homogenous State Equations.

Unit 3

Solution of Non-Homogenous State Equations – Controllability and Observability of Systems – Concepts of Output Feedback and Full State Feedback, Pole-Placement Design – Concept of an Observer – Basics of Optimal Control.

COURSE OUTCOMES

CO1: Recall Matrix Algebra and Vector Spaces, Understand basis vectors, dimension & span of vector spaces.

CO2: Define degeneracy, orthonormal set, linear transformation, Change of basis and solve simultaneous linear algebraic equations.

CO3: Derive and understand State space equations, Canonical realizations, Relate Transfer function and State space form to obtain any one from the other.

CO4: Evaluate Eigen values and Eigen vectors, Analyze Functions of square matrices and Cayley-Hamilton theorem.

CO5: Apply Controllability & Observability criteria to State feedback and Output feedback systems.

CO6: Execute arbitrary Pole placement and design State Observers to reconstruct state variables.

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

TEXTBOOKS:

1. *Friedland, B. "Control System Design", Dover, 2005.*
2. *Nise, Norman S. "Control Systems Engineering," 4th Edition, Wiley, 2004.*

Elective V

15AES440 TURBULENT FLOWS 3 0 0 3

Unit 1

Onset of Turbulence: Laminar Flow, Transition, Turbulent Flow – Laminar - Turbulent Transition: Taylor's Rotating Cylinder Experiment, Benard's Natural Convection Experiment, Reynolds Experiment, Reynolds Number Concept Based on Volume Flux and Pressure Gradient – Stability Theory of Laminar Flows: Method of Small Disturbances, Orr-Sommerfeld Equation, Modes of Stability, Curve of Neutral Stability, Indifference Reynolds Number, Absolute and Convective Instabilities.

Unit 2

Inviscid Instability: Rayleigh Equation, Point of Inflection Criteria, Critical Layer – Fundamentals of Turbulent Flow: Mean Motion, Fluctuations, Quasi-steady Approach, Apparent Viscosity, Reynolds Stresses (Momentum Theorem & Navier-Stokes Equations), Classical Empirical Results on Turbulence, Wind-tunnel Turbulence.

Unit 3

Semi-empirical Hypothesis: Eddy Viscosity, Prandtl Mixing Length – Isotropic Turbulence: Kolmogorov Hypothesis, Kolmogorov Length and Time Scales - Free Turbulent Flows: Jet Boundary, Free Jet, Wake.

COURSE OUTCOMES

CO1: Develop theoretical characterization for laminar-turbulent flow transition.

CO2: Examine the nature of turbulence based on classical theory and empirical results.

CO3: Comprehend closure problem pertinent to turbulence and make use of turbulence models to study the nature of turbulence.

CO4: Apply standard hypothesis to quantify eddy structures and implement the basic concepts to refine existing turbulence models.

CO5: Distinguish the delicate aspects of turbulent boundary layer flows from free turbulent flows

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

TEXTBOOK:

Herrmann Schlichting, Klaus Gersten, "Boundary Layer Theory," 8thedition, Springer-Verlag, 2000.

REFERENCES:

1. *Pijush K. Kundu, Ira M. Cohen, David R. Dowling, "Fluid Mechanics," 5th edition, Academic Press, 2012.*
2. *Davidson, P. A., "Turbulence: An Introduction for Scientists and Engineers," Oxford University Press, 2004.*

15AES460 SPACE FLIGHT MECHANICS 3 0 0 3

Unit 1

Elements of Conics – The n-Body Problem and Reduction to Two-Body Problem – Types of Orbits – Conservation of Energy and Angular Momentum in Orbits – Spherical Trigonometry – Geocentric-Equatorial, Heliocentric-Ecliptic, Right Ascension Declination, Topocentric-Horizon and Perifocal Co-Ordinate Systems and Transformations Between Them – Classical Orbital Elements.

Unit 2

Orbital Elements Determination from Position and Velocity at a Point – Determining Position and Velocity from Orbital Elements – Orbit Determinations from a Single Radar Observation, Three Position Vectors and Optical Sightings – Ellipsoidal Earth Model: Geodetic and Geocentric Latitudes – Ground Trace of Satellites – Solar and Sidereal Times – Precession of The Equinoxes – Low and High Earth Orbits: Orbital Perturbations due to Oblateness of Earth – Orbital Maneuvers: General Coplanar Orbit Transfer, Hohmann Transfer, Simple Plane Changes to an Orbit.

Unit 3

Time-of Flight and Eccentric Anomalies for Elliptic, Parabolic And Hyperbolic Orbits – Kepler's Problem and Solution Algorithm – Gauss Problem: General Methods of Solution – Intercept and Rendezvous with Examples – Ballistic Missile Trajectories: Effect of Earth Rotation – Interplanetary Trajectories: Spheres of Influence and the Patched Conic Approximation, Synodic Periods – Satellite Attitude Dynamics: Torque Free Motion, Stability of Torque Free Motion, Spin Stabilization, Gyroscopic Attitude Control, Gravity Gradient Attitude Control.

COURSE OUTCOMES

CO1: Understand classical orbital elements, physical principles of orbital motion and various coordinate systems
used.

CO2: Orbit element determination from position and velocity vectors. Know effects of perturbations to orbits, know ground trace and basic orbital maneuvers

CO3: Know Kepler and Gauss problem, ballistic missile trajectories, interplanetary and lunar trajectories and basics of satellite attitude dynamics

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

TEXTBOOKS:

1. *Roger R Bate, Donald D Mueller, Jerry E White and William W Saylor, "Fundamentals of Astrodynamics," 2nd edition, Dover, 2015.*
2. *Marshall H Kaplan, "Modern Spacecraft Dynamics and Control," Wiley, 1976.*

REFERENCES:

1. *Howard Curtis, "Orbital Mechanics for Engineers and Scientists," 3rd edition, Elsevier, 2010.*
2. *Marcel J. Sidi, "Spacecraft Dynamics and Control: A Practical Engineering Approach," Cambridge University Press, 1997.*

15AES471 MULTIDISCIPLINARY DESIGN OPTIMIZATION 3 0 0 3

Unit 1

Single Variable Optimization: Introduction to Optimization, Optimality Criteria – Bracketing Methods: Exhaustive Search Method, Bounding Phase Method, Region Elimination Methods, Golden Section Search Method, Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method, Cubic Search Method.

Unit 2

Multivariable Optimization: Optimality Criteria – Gradient Based Methods: Steepest Descent Method, Conjugate Direction Method, Conjugate Gradient Method and Newton's Method – Constrained Optimization: Karush-Kuhn-Tucker Optimality Criteria, Direct Methods, Indirect Methods, Penalty Function Methods.

Unit 3

Global Optimization: Simulated Annealing, Genetic Algorithm, Particle Swarm Optimization, Multi-Objective Optimization – Pareto Optimality –Global Function / Weighted Sum.

COURSE OUTCOMES

CO1: Understand the terms optimization, design variables, objective functions, constraints and the types ofoptimization.

CO2: Understand the single variable, multi-variable optimization with and without constraints.

CO3: Apply the suitable optimization algorithm for the given problem.

CO4: Analyze the accuracy of the optimization algorithms.

CO5: Understanding and apply the non-conventional optimization methods for multi-objective functions and to know about types of non-conventional optimization methods.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	1									1	3	1	2
CO2	3	2	1									1	3	1	2
CO3	3	3	2	1	1							3	3	2	3
CO4	3	3	1									1	3	2	2
CO5	3	3	2	1	1							3	3	2	3

TEXTBOOK:

Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", 2nd edition, Prentice Hall of India, New Delhi, 2012.

REFERENCES:

1. *Kalyanmoy Deb, "Multi-Objective Optimization using Evolutionary Algorithms", Wiley, 2010.*
2. *J. Arora, "Introduction to Optimum Design," 3rd Edition, Elsevier, 2012.*

Elective VI

15AES441 ADVANCED COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

Unit 1

Strong and Weak Form of Conservation of Equations – Introduction to Finite Volume Method: Discretization Schemes and their Properties for Finite Volume Method.

Unit 2

Finite Volume Method for Convection - Diffusion Problems: Central Differencing, Upwind Differencing, Power-Law Differencing, Quick and TVD Schemes with their Assessments – Staggered and Collocated Grids – Introduction to Multigrids – Flux-Vector Splitting.

Unit 3

Introduction to Solution Algorithms: SIMPLE, SIMPLER, SIMPLEC and PISO Algorithms – Introduction to Turbulence Models and Associated Parameters – Introduction to Aerodynamic Shape Optimization – Introduction to Spectral Methods.

COURSE OUTCOMES

CO1: Understanding strong and weak form of governing equation and the basics of Finite Volume Method (FVM) to discretize partial differential equations.

CO2: Applying FVM schemes like upwind, Center Difference, power-law, quick, TVD for convection-diffusiontype problems and assess the schemes.

CO3: Applying solution methodologies like SIMPLE, SIMPLER, SIMPLEC, PISO for staggered and collocated grids.

CO4: Understanding Turbulence Models and Associated parameters.

CO5: Understanding of advanced concepts: multi-grids, flux-vector splitting, spectral methods, and aerodynamicshape optimization.

CO6: Numerically model the theoretical understanding of Computational Fluid Dynamics using open-source packages such as LAMMPS, Open Foam.

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3											2	3	2	
CO2	2	2										2	2	2	
CO3	2	2											2	2	
CO4	2											2	3	2	
CO5	2	2										2	2	2	
CO6	2	2		2	3							2	2	3	2

TEXTBOOKS:

1. Hirsch, "Numerical Computation of Internal and External Flows- Vol1-2", 2nd edition, Elsevier, 2007.

2. Veertseeg. H, Malalasekara. W, "An Introduction to Computational Fluid Dynamics - The Finite Volume Approach", 2nd ed., Pearson Education Ltd., 2008.

REFERENCES:

1. *T.J. Chung, "Computational Fluid Dynamics,"2nd edition, Cambridge University Press, 2010.*
2. *John Tannehill, Dale Anderson, Richard Pletcher, "Computational Fluid Mechanics and Heat Transfer," 3rd Edition, CRC Press, 2013.*
3. *Canuto C., Hussaini M. Y., Quarteroni A., and Zang T. A., "Spectral Methods. Fundamentals in Single Domains." Springer-Verlag, 2006.*

15AES450 SURFACE ENGINEERING, COATING AND JOINING TECHNOLOGIES 3 0 0 3

Unit 1

Introduction: Engineering components, surface dependent properties and failures, importance and scope of surface engineering. Surface and surface energy: Structure and types of interfaces, surface energy and related equations. Surface modification of steel and ferrous components, Surface modification using gaseous medium: Nitriding carbonitriding (diffusion from gaseous state) (principle and scope of application).

Unit 2

Surface engineering by energy beams: General classification, scope and principles, types and intensity / energy deposition profile. Surface engineering by energy beams: Laser assisted microstructure modification – surface melting, hardening, shocking and similar processes. Surface engineering by spray techniques: Plasma coating (principle and scope of application). Characterization of surface microstructure and properties.

Unit 3

Fundamentals of Adhesive Bonding, Stress Distribution in Adhesive Bonding, Adhesive Bonding geometry and fracture analysis, Adhesive bonding of similar and dissimilar materials, Fundamentals of welding, Stress Distribution in welding.

COURSE OUTCOMES

CO1: Understanding of surface Engineering.

CO2: Application of surface Engineering.

CO3: Understanding of plasma processing of material.

CO4: Understanding of adhesive bonding.

CO5: Application of adhesive bonding

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

TEXTBOOK:

Peter M. Martin (2011), Introduction to Surface Engineering and Functionally Engineered Materials, ISBN 978-0-470-63927-6, Scrivener Publishing LLC.

REFERENCES:

1. *Arthur A. Tracton (2006), Coatings Technology Handbook, ISBN 978-1-57444-649-4, Taylor & Francis Group LLC.*
2. *Samuel Benavides (2009), Corrosion Control in the Aerospace Industry, ISBN 13: 9781845693459, Woodhead Publishing Ltd.*

15AES461 PRINCIPLES OF AIRPORT MANAGEMENT 3 0 0 3

Unit 1 Introduction

History of Aviation - Development of Air transportation in India - Major players in Airline Industry - Swot analysis in Airline Industry - Market potential of Indian Airline Industry - Current challenges in Airline Industry - Completion in Airline Industry - IATA & ICAO.

Airport management:
Airport planning - Operational area and Terminal planning, design, and operation - Airport operations - Airport functions - Organization structure of Airline and Airports sectors - Airport authorities - Global and Indian scenario of Airport management – DGCA – AAI.

Unit 2 Air transport services:

International trends - Emerging Indian scenario – PPP - Public Private Participation in Indian Airports -

Environmental regulations - Private participation in International developments - Environment regulations - Regulatory issues - Meteorological services for Aviation - Airport fees, rates, and charges.

Airline operations:
Airline Terminal Management - Flight Information Counter / Reservation and Ticketing
- Check In/Issue of Boarding pass - Customs and Immigration formalities - Co-ordination - Security Clearance - Baggage and Handling of Unaccompanied minors and Disabled Passengers - Handling of Stretcher Passengers and Human Remains - Handling of CIP, VIP & VVIP - Co-ordination of Supporting Agencies / Departments.

Unit 3

Logistics and air cargo management:
Concept of Logistics - Role of Ware Housing - trend in material handling - Global Supply Chain - Quality concept and Total Quality Management - improving Logistic performance - Air Cargo Concept - Cargo Handling - Booking of Perishable Cargo and Live Animals - Industry Relation - Type of Air Cargo - Air Cargo Tariff, ratios and Charges - Airway Bill, Function, Purpose.

COURSE OUTCOMES

CO1: Understand various functions of airport management.

CO2: Exposure to environmental regulation for airport.

CO3: Understand airline operations.

CO4: Appreciate role of logistics in airport management.

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

TEXTBOOKS:

1. *Wells. A, "Airport Planning and Management," 4th edition, McGraw-hill, London, 2000.*
2. *Alexander T. Well, Seth Young, "Principles of Airport Management," McGraw Hill 2003*

SCIENCE ELECTIVES

15CHY239 COMPUTATIONAL CHEMISTRY AND MOLECULAR MODELLING **3 0 0 3**

Unit 1

Introduction: Stability, symmetry, homogeneity and quantization as the requirements of natural changes - Born - Haber cycle – Energetic – kinetics - Principles of spectra.

Computational techniques: Introduction to molecular descriptors, computational chemistry problems involving iterative methods, matrix algebra, Curve fitting.

Molecular mechanics: Basic theory - Harmonic oscillator – Parameterization - Energy equations - Principle of coupling - Matrix formalism for two masses - Hessian matrix - enthalpy of formation - enthalpy of reactions.

Introduction to Quantum mechanics - Schrodinger equation - Position and momentu - MO formation - Operators and the Hamiltonian operator - The quantum oscillator - Oscillator Eigen value problems - Quantum numbers - labeling of atomic electrons.

Unit 2

Molecular Symmetry: Elements of symmetry - Point groups - Determination of point groups of molecules.

Huckel's MO theory: Approximate and exact solution of Schrodinger equation - Expectation value of energy - Huckel's theory and the LCAO approximation - Homogeneous simultaneous equations - Secular matrix - Jacobi method - Eigen vectors: Matrix as operator - Huckel's coefficient matrix - Wheeland's method - Hoffmann's EHT method - Chemical applications such as bond length, bond energy, charge density, dipole moment, Resonance energy.

Unit 3

Self consistent fields: Elements of secular matrix - Variational calculations - Semi empirical methods - PPP self consistent field calculation - Slater determinants - Hartree equation - Fock equation – Roothaan - Hall equation - Semi empirical models and approximations.

Ab-initio calculations: Gaussian implementations – Gamess - Thermodynamic functions - Koopman's theorem - Isodesmic reactions, DFT for larger molecules - Computer aided assignments/mini projects with softwares - Introduction to HPC in Chemical calculations.

Molecular modelling software engineering - Modeling of molecules and processes - Signals and signal processing in Chemistry - QSAR studies and generation of molecular descriptors - Applications of chemical data mining - Familiarization with open source softwares useful for molecular modeling - Introduction to molecular simulation - M.D. simulation.

Course Outcome

CO01: Get to understand the structure of molecules using symmetry.

CO02: Understanding Quantum mechanical approach to calculate the energy of a system.

CO03: Applying mathematical knowledge and quantum mechanical approach in finding out the characteristics- reactivity, stability, etc., of the molecule.

CO04: To get a brief idea about molecular mechanics based chemical calculations.

CO05: To get an idea about general methodology of molecular modeling.

TEXTBOOKS:

1. *Ramachandran, G Deepa and K Namboori, "Computational Chemistry and Molecular Modeling - Principles and Applications", Springer-Verlag, Berlin, Heidelberg, 2008, ISBN-13 978-3-540-77302-3.*
2. *Donald W Rogers, "Computational Chemistry Using PC", Wiley, (2003).*
3. *Alan Hinchliffe, "Chemical Modeling from atoms to liquids", Wiley, (2005).*

REFERENCES:

1. *James B Forseman and Aeleen Frisch-Gaussian, "Exploring Chemistry with Electronic Structure Method", Inc., Pittsburgh, PA, 2nd edition, (2006).*
2. *A C Philips, "Introduction to Quantum mechanics", Wiley, (2003).*
3. *Wolfram Koch, Max C. Holthausen, "A Chemist's guide to Density Functional Theory", Wiley, VCH, 2nd edition, (2001).*

15CHY241 ELECTROCHEMICAL ENERGY SYSTEMS AND PROCESSES 3 0 0 3

Unit 1

Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicator and ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler-Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafel plots - exchange current density and transfer coefficients.

Unit 2

Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air, zinc-silver oxide batteries; lithium primary cells - liquid cathode, solid cathode and polymer electrolyte types and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: ARM (alkaline rechargeable manganese) cells, Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultra thin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3

Reserve batteries and Fuel cells: Reserve batteries - water activated, electrolyte activated and thermally activated batteries - remote activation - pyrotechnic materials. Fuel Cells:Principle, chemistry and functioning - carbon, hydrogen-oxygen, proton exchange membrane (PEM), direct methanol (DMFC), molten carbonate electrolyte (MCFC) fuel cells and outline of biochemical fuel cells.

Electrochemical Processes: Principle, process description, operating conditions, process sequence and applications of Electroforming – production of waveguide and plated through hole (PTH) printed circuit boards by electrodeposition; Electroless plating of nickel, copper and gold; Electropolishing of metals; Anodizing of aluminium; Electrochemical machining of metals and alloys.

Course Outcomes

CO01: Understand the fundamental concepts of electrochemistry through electrode potential and reaction kinetics

CO02: Learn the application of the electrochemical principles for the functioning and fabrication of industrial batteries and fuel cells

CO03: Acquire knowledge in solving numerical problems on applied electrochemistry

CO04: Analysis and practical problem solving in fabrication of batteries and fuel cells

CO05: Application of concepts and principle in industrial electrochemical processes

CO06: Evaluation of comprehensive knowledge through problem solving

TEXTBOOKS:

1. *Derek Pletcher and Frank C. Walsh, "Industrial Electrochemistry", Blackie Academic and Professional, (1993).*
2. *Dell, Ronald M Rand, David A J, "Understanding Batteries", Royal Society of Chemistry, (2001).*

REFERENCES:

1. *Christopher M A, Brett, "Electrochemistry – Principles, Methods and Applications", Oxford University, (2004).*
2. *Watanabe T, "Nano-plating: microstructure control theory of plated film and data base of plated film microstructure", Elsevier, Oxford, UK (2004).*
3. *Kanani N, "Electroplating and electroless plating of copper and its alloy", ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).*
4. *Lindon David, "Handbook of Batteries", McGraw Hill, (2002).*
5. *Curtis, "Electroforming", London, (2004).*
6. *Rumyantsev E and Davydov A, "Electrochemical machining of metals", Mir, Moscow, (1989).*

15CHY243 FUELS AND COMBUSTION 3 0 0 3

Course Objectives: To provide the basic knowledge about fuels, rocket propellants and explosives.

Course Outcomes

CO01: Understand the types of fuels and variation in their properties

CO02: Able to analyze the fuel content

CO03: Obtain knowledge in identifying a proper fuel as per the requirement

CO04: Ability to know the preparation and working of propellants and explosives

Skill: This course enables the student to gain skill in identifying fuel, analyzing and categorize the application of it.

Unit 1

Fuels - Solid fuels - Classification, preparation, cleaning, analysis, ranking and properties - action of heat, oxidation, hydrogenation, carbonization, liquefaction and gasification.

Liquid fuels – Petroleum - origin, production, composition, classification, petroleum processing, properties, testing - flow test, smoke points, storage and handling.

Secondary liquid fuels - Gasoline, diesel, kerosene and lubricating oils. Liquid fuels - refining, cracking,

fractional distillation, polymerization. Modified and synthetic liquid fuels. ASTM methods of testing the fuels.

Unit 2

Gaseous fuels - Types, natural gas, methane from coal mine, water gas, carrier gas, producer gas, flue gas, blast furnace gas, biomass gas, refinery gas, LPG - manufacture, cleaning, purification and analysis. Fuels for spark ignition engines, knocking and octane number, anti knock additives, fuels for compression, engines, octane number, fuels for jet engines and rockets.

Flue gas analysis by chromatography and sensor techniques.

Unit 3

Combustion: Stochiometry, thermodynamics. Nature and types of combustion processes - Mechanism - ignition temperature, explosion range, flash and fire points, calorific value, calorific intensity, theoretical flame temperature. Combustion calculations, theatrical air requirements, flue gas analysis, combustion kinetics – hydrogen - oxygen reaction and hydrocarbon - oxygen reactions.

Rocket propellants and Explosives - classification, brief methods of preparation, characteristics; storage and handling.

TEXTBOOK:

Fuels and Combustion, Samir Sarkar, Orient Longman Pvt. Ltd, 3rd edition, 2009.

REFERENCE:

3. *Fuels - Solids, liquids and gases - Their analysis and valuation, H. Joshua Philips, Biobliolife Publisher, 2008.*
4. *An introduction to combustion: Concept and applications - Stephen R Turns, Tata Mc. Graw Hill, 3rd edition, 2012.*
5. *Fundamentals of Combustion, D P Mishra, 1st edition, University Press, 2010*
6. *Engineering Chemistry - R. Mukhopadhyay and Sriparna Datta, Newage International Pvt. Ltd, 2007.*

15CHY244 GREEN CHEMISTRY AND TECHNOLOGY 3 0 0 3

Objectives

1. Understand the principles of green chemistry and its contribution to the development of sustainable products
2. Possess knowledge of the migration from a hydrocarbon-based economy to carbohydrate-based economy
3. Evaluate the deficiencies of traditional process and acknowledge the invent of new processes
4. Distinctly map the culmination of academic research to industrial chemistry

Course Outcomes

CO01: Understand the evolving concept of Green Chemistry and its application to the manufacture of sustainable products

CO02: Appreciate the need for Renewable energy and Feed stock along with carbon sequestration through the fundamentals of Green Chemistry Techniques

CO03: Develop a coherence to evaluate systematic deficiencies in traditional Chemical science process and products

CO04: Undertake a purposeful Journey through the microscopic domain of academic research to the macroscopic domain of Industrial chemistry

Unit 1

Our environment and its protection, chemical pollution and environmental regulations, environmental chemistry, pollution prevention strategies, challenges to the sustainability of chemical industry, Pollution Prevention Act 1990, USA, Green Chemistry and its 12 principles, toxicity of chemicals, material safety data sheet (MSDS), concept of zero pollution technologies, atom economy, functional toxicity vs non-functional toxicity, alternative solvents, energy minimization, microwave and sonochemical reactions, renewable feed stock, carbon dioxide as a feed stock.

Unit 2

Greener strategies of the synthesis of ibuprofen synthesis, teriphthalic acid etc. phase behaviour and solvent attributes of supercritical CO2, use of supercritical carbon dioxide as a medium chemical industry, use of ionic liquids as a synthetic medium, gas expanded solvents, superheated water, etc. Synthesis of various chemicals from bio mass, polycarbonate synthesis and CO2 fixation, green plastics, green oxidations, etc.

Unit 3

Processes involving solid catalysts – zeolites, ion exchange resins, Nafion/silica nano composites and enhanced activity. Polymer supported reagents, green oxidations using TAML catalyst, membrane reactors. Green chemistry in material science, synthesis of porous polymers, green nanotechnology.

REFERENCES:

3. *Hand Book of Green Chemistry and Technology; by James Clarke and Duncan Macquarrie; Blakwell Publishing.*
4. *Anastas, P. T., Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press Inc., New York, 1998.*
5. *Matlack, A. S. Introduction to Green Chemistry Marcel Dekker: New York, NY, 2001.*

15CHY245 INSTRUMENTAL METHODS OF ANALYSIS 3 0 0 3

Unit 1

Error Analysis and Sampling: Accuracy - Precision - Classification of Errors - Minimization of errors - Standard deviation - Coefficient of variance - F-test - t-test - Significant figures. Sampling - Basis of sampling, Sampling and physical state - Safety measures of sampling.

Separation Techniques: Brief out line of column, paper and thin layer chromatography - Ion exchange methods - principle and application – HPLC.

Unit 2

Gas chromatography - principle and applications – gel chromatography.

Electroanalytical techniques: Potentiometry - Potentiometric titration - determination of equivalence point - acid base, complexometric, redox and precipitation titrations - merits and demerits. Voltammetry - Cyclic voltammetry - basic principle and application - Polarography - introduction - theoretical principles - migration current - residual current - half wave potential - instrumentation - analytical applications.

Unit 3

Spectro-chemical techniques: UV-VIS spetrophotometry - principle - Beer's Law application - photometric titration - single and double beam spectrophotometer - instrumentation of IR - sample handling - IR applications - H - NMR - Instrumentation and applications - principle - instrumentation - applications of atomic absorption spectroscopy.

Thermal and Diffraction techniques: Principles and applications of DTG - DTA - DSC - X-ray - Electron Diffraction Studies - SEM, TEM.

Course Outcome

CO01: To develop an understanding of principle and working of the range of instrumental methods in analytical chemistry

CO02: To provide an understanding and skills in contemporary methods of separation and appropriate selection of instruments for the successful analysis of chemical compounds

CO03: To impart skills in the scientific method of planning, conducting, reviewing, reporting experiments and problem solving in chemical analysis.

TEXTBOOKS:

1. *Willard H W, Merritt J R, "Instrumental Methods of Analysis", 6th edition, Prentice Hall, (1986).*
2. *Skoog Douglas A, West Donald, "Fundamentals of Analytical Chemistry", 7th edition, New York Addison, Wesley, (2001).*

REFERENCES:

1. *"Vogel's Textbook of Quantitative Chemical Analysis", 5th edition, ELBS, (1989).*
2. *Kaur. H, "Instrumental Methods of Chemical Analysis", Goel Publisher, (2001).*

15CHY331 BATTERIES AND FUEL CELLS 3 0 0 3

Course Objective: To provide sound knowledge on the application of electrochemistry in energy storage systems.

Course Outcome

CO01: Understand the fundamental concepts of electrochemistry through electrode potential and reaction kinetics

CO02: Learn the application of the electrochemical principles for the functioning and fabrication industrial batteries and fuel cells

CO03: Analysis of practical problem solving in fabricating batteries and fuel cells

CO04: Evaluation of comprehensive knowledge through problem solving

Unit 1

Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicator and ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler-Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafel plots - exchange current density and transfer coefficients.

Unit 2

Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air batteries; Lithium primary cells - liquid cathode, solid cathode and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-

zinc, nickel-metal hydride batteries, lithium ion batteries, ultrathin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3

Fuel Cells: Description, working principle, anodic, cathodic and cell reactions, fabrication of electrodes and other components, applications, advantages, disadvantages and environmental aspectsof the following types of fuel cells: Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells.

Membranes for fuel cells: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments.

Fuels for Fuel Cells: Hydrogen, methane, methanol - Sources and preparation, reformation processes for hydrogen – clean up and storage of the fuels – use in cells, advantages and disadvantages of using hydrogen as fuel.

TEXTBOOKS:

3. *Dell, Ronald M Rand, David A J, 'Understanding Batteries', Royal Society of Chemistry, (2001).*
4. *M. Aulice Scibioh and B. Viswanathan 'Fuel Cells – principles and applications', University Press, India (2006).*

REFERENCES:

- *Kanani N, 'Electroplating and electroless plating of copper and its alloy', ASM International, Metals Park, OH and Metal Finishing Publications,Stevenage, UK (2003).*
- *Curtis, 'Electroforming', London, (2004).*
- *F. Barbir, 'PEM fuel cells: theory and practice', Elsevier, Burlington, MA, (2005).*
- *G. Hoogers, 'Fuel cell handbook', CRC, Boca Raton, FL, (2003).*

15CHY332 CORROSION SCIENCE 3 0 0 3

Unit 1

Basic principles: Free energy concept of corrosion - different forms of corrosion - Thermodynamic & Kinetic aspects of corrosion: The free energy criterion of corrosion possibility - Mechanism of Electrochemical corrosion - Galvanic and Electrochemical series and their significance.

Corrosion Control: Materials selection - metals and alloys - metal purification - non metallic - changing medium.

Unit 2

Anodic and cathodic protection methods - Coatings - metallic and other inorganic coatings - organic coatings - stray current corrosion - cost of corrosion control methods.

Corrosion protection by surface treatment: CVD and PVD processes - Arc spray - Plasma spray - Flame spray.

Corrosion Inhibitors: Passivators - Vapour phase inhibitor.

Unit 3

Stress and fatigue corrosion at the design and in service condition - control of bacterial corrosion.

Corrosion protection: Automobile bodies – engines – building construction.

Course Outcome:

CO01: Development of skill in identifying the nature and type of corrosion

CO02: Understanding the mechanism of various types of corrosion

CO03: Analysing the problem and find out a solution to combat corrosion in any sort of environment.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	-	-	-	-	-	-	-	-	-	-	3	1	-	-
CO2	-	3	1	2	-	-	-	-	-	-	-	1	1	2	-	-
CO3	-	3	3	3	2	3	3	-	-	-	-	1	3	2	3	-

TEXTBOOKS:

1. *Fontana and Mars G, "Corrosion Engineering", 3rd edition, McGraw Hill, (1987).*
2. *Uhlig H H and Reviees R W, "Corrosion and its Control", Wiley, (1985).*

REFERENCES:

1. *ASM Metals Handbook, "Surface Engineering", Vol. 5, ASM Metals Park, Ohio, USA, (1994).*
2. *ASM Metals Handbook, "Corrosion", Vol. 13, ASM Metals Park, Ohio, USA, (1994).*
3. *Brain Ralph, "Material Science and Technology", CRC Series, Boston, New York.*

15PHY230 ADVANCED CLASSICAL DYNAMICS 3 0 0 3

Unit 1

Introduction to Lagrangian dynamics

Survey of principles, mechanics of particles, mechanics of system of particles, constraints, D'Alembert's principle and Lagrange's equation, simple applications of the Lagrangian formulation, variational principles and Lagrange's equations, Hamilton's principles, derivation of Lagrange's equations from Hamilton's principle, conservation theorems and symmetry properties.

Unit 2

Central field problem

Two body central force problem, reduction to the equivalent one body problem, Kepler problem, inverse square law of force, motion in time in Kepler's problem, scattering in central force field, transformation of the scattering to laboratory system, Rutherford scattering, the three body problem.

Rotational kinematics and dynamics

Kinematics of rigid body motion, orthogonal transformation, Euler's theorem on the motion of a rigid body.

Unit 3

Angular momentum and kinetic energy of motion about a point, Euler equations of motion, force free motion of rigid body.

Practical rigid body problems

Heavy symmetrical spinning top, satellite dynamics, torque-free motion, stability of torque-free motion - dual-spin spacecraft, satellite maneouvering and attitude control - coning maneuver - Yo-yo despin mechanism - gyroscopic attitude control, gravity-gradient stabilization.

Course Outcomes

CO1 - Able to use the Lagrangian formalism to solve simple dynamical system

CO2- Able to understand Hamiltonian formalism and apply this in solving dynamicalsystems

CO3- Able to apply Lagrangian formalism in bound and scattered states with specific reference to Kepler’s laws and Scattering states

CO4- Able to solve problems in the Centre of Mass frame and connect it to Laboratory Frame of Reference

CO5- Understand and solve problems in rigid body rotations applying of Euler's equations.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	0	0	0	0	0	0	0	1	0	0	0
CO2	3	3	1	1	0	0	0	0	0	0	0	1	0	0	0
CO3	3	3	3	1	0	0	0	0	0	0	0	1	0	0	0
CO4	3	3	3	1	0	0	0	0	0	0	0	2	0	0	0
CO5	3	3	3	2	0	0	0	0	0	0	0	2	0	0	0

TEXTBOOKS:

1. H. Goldstein, Classical Mechanics, Narosa Publishing House, New Delhi, 1980, (Second Edition)

2. H. Goldstein, Charles Poole, John Safko, Classical Mechanics, Pearson education, 2002 (Third Edition)
3. Howard D. Curtis, Orbital Mechanics for Engineering Students, Elsevier, pp.475 - 543

4. Anderson John D, Modern Compressible flow, McGraw Hill.

REFERENCE BOOKS:

1. D. A. Walls, Lagrangian Mechanics, Schaum Series, McGraw Hill, 1967.

2. J. B. Marion and S. T. Thornton, Classical dynamics of particles and systems, Ft. Worth, TX: Saunders, 1995.

15PHY238 ELECTRICAL ENGINEERING MATERIALS 3 0 0 3

Unit 1

Conducting materials: The nature of chemical bond, crystal structure Ohm's law and the relaxation time, collision time, electron scattering and resistivity of metals, heat developed in a current carrying conductor, thermal conductivity of metals, superconductivity.

Semiconducting materials: Classifying materials as semiconductors, chemical bonds in Si and Ge and it's consequences, density of carriers in intrinsic semiconductors, conductivity of intrinsic semiconductors, carrier densities in n type semiconductors, n type semiconductors, Hall effect and carrier density.

Unit 2

Magnetic materials: Classification of magnetic materials, diamagnetism, origin of permanent, magnetic dipoles in matter, paramagnetic spin systems, spontaneous magnetization and Curie Weiss law, ferromagnetic domains and coercive force, anti ferromagnetic materials, ferrites and it's applications.

Unit 3

Dielectric materials: Static dielectric constant, polarization and dielectric constant, internal field in solids and liquids, spontaneous polarization, piezoelectricity.

PN junction: Drift currents and diffusion currents, continuity equation for minority carriers, quantitative treatment of the p-n junction rectifier, the n-p-n transistor.

Course Outcomes

CO1: To understand the nature of interaction between atoms in crystalline solid materials that determines their dielectric, magnetic and electrical properties.

CO2: Analyze the relation between the macroscopic dielectric constant and the atomic structure of an insulator.

CO3: Fundamental concepts of magnetic fields required to illustrate the magnetic dipoles. This forms the basis to understand the magnetic properties of dia, para, ferro, antiferro and ferri magnetic materials.

CO4: Fundamentals concerned with conduction mechanism in metals and superconductors.

CO5: Understand the basics for classification of materials based on its conductivity, nature of chemical bonds in Si and Ge, carrier density, energy band structure and conduction mechanism in intrinsic and extrinsic semiconductors.

CO-PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	1	1											1	-
CO2	2	2	2										1	-
CO3	2	2	2										2	-
CO4	2	2	2										2	-
CO5	2	2	2					2					1	-

TEXTBOOK:

A J Decker, "Electrical Engineering materials", PHI, New Delhi, 1957.

REFERENCES:

1. A J Decker, "Solid State Physics", Prentice Hall, Englewood Cliffs, N J 1957.
2. C Kittel, "Introduction to solid state Physics", Wieley, New York, 1956 (2nd edition).
3. Allison, Electronic Engineering materials and Devices, Tata Mc Graw Hill
4. F K Richtmyer E H Kennard, John N Copper, "Modern Physics", Tata Mc Graw Hill, 1995 (5th edition).

15PHY248 PHYSICS OF LASERS AND APPLICATIONS 3 0 0 3

Unit 1

Review of some basic concepts and principle of laser.

Introduction to light and its properties: Reflection, refraction, interference, diffraction and polarization. Photometry – calculation of solid angle. Brewster's law. Snell's law and, its analysis.

Introduction to LASERS: Interaction of radiation with matter - induced absorption, spontaneous emission, stimulated emission. Einstein's co-efficient (derivation). Active material. Population

inversion – concept and discussion about different techniques. Resonant cavity.

Unit 2

Properties of LASERS

Gain mechanism, threshold condition for PI (derivation), emission broadening - line width, derivation of FWHM natural emission line width as deduced by quantum mechanics - additional broadening process: collision broadening, broadening due to dephasing collision, amorphous crystal broadening, Doppler broadening in laser and broadening in gases due to isotope shifts. Saturation intensity of laser, condition to attain saturation intensity.

Properties – coherency, intensity, directionality, monochromaticity and focussibility. LASER transition – role of electrons in LASER transition, levels of LASER action: 2 level, 3 level and 4 level laser system.

Unit 3

Types of LASERS

Solid state LASER: (i) Ruby LASER – principle, construction, working and application. (ii) Neodymium (Nd) LASERS. gas LASER: (i) He-Ne LASER - principle, construction, working and application. (i) CO2 LASER - principle, construction, working and application.

Liquid chemical and dye LASERS. Semiconductor LASER: Principle, characteristics, semiconductor diode LASERS, homo-junction and hetero-junction LASERS, high power semi conductor diode LASERS.

Applications in Communication field:

LASER communications: Principle, construction, types, modes of propagation, degradation of signal, analogue communication system, digital transmission, fiber optic communication.

Applications of LASERS in other fields:

Holography: Principle, types, intensity distribution, applications. laser induced fusion. Harmonic generation. LASER spectroscopy. LASERS in industry: Drilling, cutting and welding. Lasers in medicine: Dermatology, cardiology, dentistry and ophthalmology.

Course Outcomes

CO 1- Understand, Comprehend and acquaint with concepts of NanoPhysics

CO2- To familiarize the material's property changes with respect to the dimensional confinements.

CO3- Acquire knowledge on the modern preparation process and analysis involved in the nanomaterial's research

CO4- To learn about the technological advancements of the nano-structural materials and devices in the engineering applications

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	2												
CO2	2	3												
CO3				3										
CO4						3	2					1		

REFERENCES:

1. William T Silfvast, "Laser Fundamentals", Cambridge University Press, UK (2003).
2. B B Laud, "Lasers and Non linear Optics", New Age International (P) Ltd., New Delhi.
3. Andrews, "An Introduction to Laser Spectroscopy (2e)", Ane Books India (Distributors).
4. K R Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd., New Delhi.
5. T Suhara, "Semiconductor Laser Fundamentals", Marcel Dekker (2004).

15PHY532 ASTROPHYSICS 3 0 0 3

Unit 1

Historical introduction: Old Indian and western – astronomy - Aryabhatta, Tycho Brahe, Copernicus, Galileo - Olbers paradox - solar system – satellites, planets, comets, meteorites,

asteroids.

Practical astronomy - telescopes and observations & techniques – constellations, celestial coordinates, ephemeris.

Celestial mechanics - Kepler's laws - and derivations from Newton's laws.

Sun: Structure and various layers, sunspots, flares, faculae, granules, limb darkening, solar wind and climate.

Unit 2

Stellar astronomy: H-R diagram, color-magnitude diagram - main sequence - stellar evolution

– red giants, white dwarfs, neutron stars, black holes - accretion disc - Schwartzchild radius - stellar masses Saha–Boltzman equation - derivation and interpretation.

Variable stars: Cepheid, RR Lyrae and Mira type variables - Novae and Super novae. Binary and multiple star system - measurement of relative masses and velocities. Interstellar clouds - Nebulae.

Unit 3

Galactic astronomy: Distance measurement - red shifts and Hubble's law – age of the universe, galaxies – morphology - Hubble's classification - gravitational lens, active galactic nuclei (AGNs), pulsars, quasars.

Relativity: Special theory of relativity - super-luminal velocity - Minkowski space - introduction to general theory of relativity – space - time metric, geodesics, space-time curvature. Advance of perihelion of Mercury, gravitational lens.

Cosmology: Comic principles, big bang and big crunch – cosmic background radiation - Nucleo-synthesis - plank length and time, different cosmic models - inflationary, steady state. Variation of G. anthropic principle.

COURSE OUTCOMES (CO):

After completion of the course students should be able to

CO1: Get a broad knowledge of scientific and technical methods in astronomy and astrophysics.
CO2: Apply mathematical methods to solve problems in astrophysics.
CO3: Develop critical/logical thinking, scientific reasoning and skills in the area of modern astrophysics.

CO-PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3											1		
CO2	2	2												
CO3	1	2												

REFERENCES:

1. "Textbook of Astronomy and Astrophysics with elements of Cosmology", V. B. Bhatia, Narosa publishing 2001.
2. William Marshall Smart, Robin Michael Green "On Spherical Astronomy", (Editor) Carroll, Bradley W Cambridge University Press ,1977
3. Bradley W.Carroll and Dale A. Ostlie. "Introduction to modern Astrophysics" Addison-Wesley, 1996.
4. Bradley W.Carroll and Dale A. Ostlie, "An Introduction to Modern Astrophysics" Addison-Wesley Publishing Company,1996
5. 'Stellar Astronomy' by K. D Abhayankar.
6. 'Solar Physics' by K. D Abhayankar.

HUMANITIES ELECTIVES

15ENG230 BUSINESS COMMUNICATION 1 0 2 2

Course Objectives

To introduce business vocabulary
T o introduce business style in writing and speaking
To expose students to the cross-cultural aspects in a globalised world
To introduce the students to the art of persuasion and negotiation in business contexts

Course Outcomes

CO1	Familiarize and use appropriate business vocabulary and etiquettes in verbal communication in the professional context
CO2	Understand organizational structures, pay structures and performance assessments
CO3	Apply language skills in drafting various business documents and other necessary communications in the business context
CO4	Understand and address cross cultural differences in the corporate environment
CO5	articipate in planned and extempore enactments of various business situations

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO 3	PO4	PO5	PO 6	PO7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1										3		2
CO2									1		1	
CO3										3		
CO4						2						
CO5									2			

Syllabus

Unit 1:

Business Vocabulary - Writing: Drafting Notices, Agenda, and Minutes - Reading: Business news, Business articles

Unit 2:

Writing: Style and vocabulary - Business Memorandum, letters, Press Releases, reports – proposals – **Speaking**: Conversational practice, telephonic conversations, addressing a gathering, conducting meetings

Unit 3:

Active Listening: Pronunciation – information gathering and reporting **- Speaking**: Cross-Cultural Issues, Group Dynamics, negotiation & persuasion techniques

Activities

Case studies & role-plays

Books recommended:

1. Jones, Leo & Richard Alexander. *New International Business English*. CUP. 2003.
2. Horner, David & Peter Strutt. *Words at Work*. CUP. 1996.
3. Levi, Daniel. *Group Dynamics for Teams*. 3 ed. Sage Publications India Pvt. Ltd. New Delhi, 2011.
4. Owen, Roger. *BBC Business English*. BBC. 1996.
5. Henderson, Greta Lafollette & Price R Voiles. *Business English Essentials*. 7th Edition. Glencoe / McGraw Hill.
6. Sweeney, Simon. *Communicating in Business*. CUP. 2000.

15ENG233 TECHNICAL COMMUNICATION 1 0 2 2

Course Objectives:

To introduce the students to the elements of technical style

To introduce the basic elements of formal correspondence

To introduce technical paper writing skills and methods of documentation

To improve oral presentation skills in formal contexts

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand and use the basic elements of formal correspondence and methods of documentation
CO2	Learn to edit technical content for grammatical accuracy and appropriate tone and style
CO3	Use the library and internet recourses for research purposes
CO4	Demonstrate the ability to communicate effectively through group mock-technical presentations and other activities

Mapping of course outcomes with program outcomes:

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

Syllabus:

Unit 1

Mechanics of writing: Grammar rules – punctuation - spelling rules - tone and style- graphical Representation

Unit 2

Different kinds of written documents: Definitions - descriptions- instructions-recommendations- manuals - reports – proposals; Formal Correspondence: Letter Writing including job applications with Resume

Unit 3

Technical paper writing: Library research skills- documentation style - document editing – proof reading - formatting

Practice in oral communication: Practice in Oral communication and Technical presentations

References

1. Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002
2. Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003
3. Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyan & Bacon, 1999.
4. Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.

15HIN101 HINDI I 1 0 2 2

To teach Hindi for effective communication in different spheres of life:- Social context , Education, Research & Media.

Course Outcomes: After the completion of the course the student will be able to:

CO1 Gain knowledge about the nature and culture of Hindi language
CO2 Understand the structural aspects of Hindi language
CO3 Apply the knowledge of the grammatical structures to communicate in Hindi
CO4 Analyse the social significance of modern literature.
CO5 Develop the ability to translate a given text to Hindi

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1									**2**	**3**				
CO2									**2**	**3**				
CO3									**2**	**3**				
CO4										**3**				
CO5									**2**					

Syllabus

Unit-1

Introduction to Hindi Language, -National Language, Official Language, link Language etc.. S Introduction to Hindi language , Devanagari script and Hindi alphabet.
Shabda Bhed , Roopanthar ki Drishti se- Bhasha – Paribhasha aur Bhed - Sangya - Paribhasha Aur Bhed- Sangya ke Roopanthar- kriya.

Unit-2

Common errors and error corrections in Parts of Speech with emphasis on use of pronouns, Adjective and verb in different tenses – Special usage of adverbs, changing voice and conjunctions in sentences, gender& number - General vocabulary for conversations in given context –understanding proper pronunciation – Conversations, Interviews, Short speeches.

Unit -3

Poems – Kabir Ist 8 Dohas, Surdas 1st 1 Pada; Tulsidas 1st 1 Pada; Meera 1st 1 Pada

Unit- 4

Letter writing – personal and Formal –Translation from English to Hindi

Unit- 5

Kahani –Premchand : Kafan , Abhilasha, Vidroh, Poos ki rath, Juloos

Text Books :

1. Prem Chand Ki Srvashrestha Kahaniyam: Prem Chand ; Diamond Pub Ltd. New Delhi
2. Vyavaharik Hindi Vyakaran ,Anuvad thaha Rachana : Dr. H. Parameswaran, Radhakrishna publishing House,New Delhi
3. Kamtha Prasad Guru : Hindi Vyakaran, Best Book pub House, New Delhi
4. Poetry : Kavya Ras-Ed: T.V. Basker- Pachouri Press; Mathura

15HIN111 HINDI II 1 0 2 2

Appreciation and assimilation of Hindi Literature - both *drishya* and *shravya* - using the best specimens provided as anthology.

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand the grammatical structures of Hindi
CO2	and the post modern trends of literature
CO3	e critical thinking and writing skills
CO4	and analyse different literary and audio-visual material
CO5	undamental knowledge of Hindi in formal and informal writing

Mapping of course outcomes with program outcomes:

Course Outcomes	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	PSO2
CO1									**1**	**2**				
CO2									**1**	**2**				
CO3									**1**	**2**				
CO4										**3**				
CO5									**1**	**2**				

Syllabus:

Unit -1

Kavya Tarang;-Dhumil ke Anthim Kavitha[Poet-Dhumil],Dhabba[Poet-Kedarnath Singh],Proxy[Poet-Venugopal],Vakth[Poet-Arun Kamal],Maachis[Poet-Suneeta Jain].

Unit -2

Communicative Hindi - Moukhik Abhivyakthi

Unit -3

Audio- Visual –Media in Hindi – Movies like Tare Zameen par , Paa, Black etc., appreciation and evaluation . News reading and presentations in Radio and TV channels in Hindi .

Unit -4

Gadya Manjusha – Budhapa , Kheesa, Sadachar ka Thavis

Unit -5

Translation: Theory and Practice - Letter writing: Formal and Personal – Introduction to Hindi Software.

Text Books:

1. Kavay Tarang : Dr. Niranjan , Jawahar Pusthakalay , Mathura.
2. Gadya Manjusha: Editor: Govind , Jawahar Pusthakalay , Mathura
3. Prem Chand Ki Srvashrestha Kahaniyam: Prem Chand ; Diamond Pub Ltd. New Delhi
4. Kamtha Prasad Guru : Hindi Vyakaran, Best Book pub House, New Delhi
5. 5.Poetry : Kavya Ras-Ed: T.V. Basker- Pachouri Press; Mathura

15HUM239 PSYCHOLOGY FOR EFFECTIVE LIVING 2 0 0 2

Course Objectives

1. To help students acquire the basic knowledge of behavior and effective living
2. To create an awareness of the hazards of health compromising behaviours
3. To develop and strengthen the tools required to handle the adversities of life

Course Outcome

CO 1: Understand the basic concepts of Behavioral Psychology
CO 2: Demonstrate self reflective skills through activities
CO 3: Apply the knowledge of psychology to relieve stress
CO 4: Analyse the adverse effects of health compromising behaviours.
CO 5: Evaluate and use guided techniques to overcome and cope with stress related problems.

CO-PO Mapping

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

Syllabus

Unit 1

SELF AWARENESS & SELF MOTIVATION

Definition of motivation-Maslow's hierarchy of motivation-Self-analysis through SWOT and Johari window - Importance of self-esteem and Enhancement of self-esteem-techniques and Strategies for self-motivation.

Unit 2

THE NATURE AND COPING OF STRESS

Definition of stress, stressors, eustress, distress-PTSD-stress among college students- stress assessment-coping with stress-progressive muscle relaxation-RET-guided imagery-bio feedback-religious and spiritual way of coping with stress

Unit 3

APPLICATION OF HEALTH PSYCHOLOGY

Health compromising behaviors-smoking and alcoholism-biological and psychological effects of addiction-deaddiction-behavior modifications-CBT in handling problem behavior-cancer risks-AIDS.

Text Book(s)

V.D.Swaminathan&K.V.Kaliappan, Psychology for Effective living-An introduction to Health

Reference(s)

1.S.Sunder. (2002). Textbook of Rehabilitation,2nd edition,Jaypee Brothers,New Delhi.
2.Weiben&Lloyd. (2004). Psychology applied to Modern Life,Thompson Learning,Asia Ltd.

15HUM240 PSYCHOLOGY FOR ENGINEERS 2 0 0 2

Course Objectives

1. To strengthen the fundamental knowledge of human behavior
2. To strengthen the ability to understand the basic nature and behavior of humans in organizations as a whole
3. To connect the concepts of psychology to personal and professional life

Course Outcome

CO 1: Understand the fundamental processes underlying human behavior such as learning, motivation, individual differences, intelligence and personality.
CO 2: Apply the principles of psychology in day- to- day life for a better understanding of oneself and others.
CO 3: Apply the knowledge of Psychology to improve study skills and learning methods
CO 4: Apply the concepts of defense mechanisms to safeguard against abusive relationships and to nurture healthy relationships.

CO-PO Mapping

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

Syllabus

Unit 1

PSYCHOLOGY OF ADOLESCENTS

Psychology-definition-scope-adolescence-characteristics-developmental tasks-physical and psychological changes-interests-family relationships-emotions-peer pressure-positive and Negative effects of peer pressure-types of friends-choice of friends

Unit 2

LEARNING, MEMORY AND STUDY SKILLS

Definitions-Classical conditioning-Operant conditioning-Insight learning-reinforcement-its principles and its effects-role of reward and punishment in learning-forgetting-causes-techniques for improving study skills-Mnemonics-Intelligence-Emotional and social intelligence

Unit 3

ATTENTION & PERCEPTION

Definition-types of attention-span of attention-division of attention- factors determining attention-perception-difference between sensation and perception-laws of perception-errors in perception-illusion and hallucination

Text Book(s)

S.K.Mangal General Psychology,Sterling Publishers Pvt.Ltd.2007

Reference(s)

1.Elizabeth B. Hurlock, Developmental Psychology - A Life span approach,6th edition
2.Cliffordm Organ, Richard King, John Scholper, Introduction to Psychology, Tata McGraw Hill, Pvt Ltd 2004.

15HUM244 UNDERSTANDING SCIENCE OF FOOD AND NUTRITION 1022

Course Objectives:

- To introduce the significance of food, nutrients, locally available food resources, synergic food combinations, good cooking methods and importance of diversity in foods
- To understand nutritional imbalances and chronic diseases associated with the quality of food.
- To gain awareness about the quality of food - Organic food, genetically modified food, adulterated food, allergic food, , food poisoning and food safety.
- To understand food preservation processing, packaging and the use of additives.

Course Outcome:

CO1: Acquire knowledge about the various food and food groups
CO2: Understand nutritional imbalances and chronic diseases prevailing among different age groups.
CO3: Understand the significance of safe food and apply the food safety standards
CO4: Demonstrate skills of food processing, preservation and packaging methods with or without additives
CO5: Evaluate the quality of food based on the theoretical knowledge of Food and Nutrition

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1		1	1			1	2	1	1	1	1	3
CO 2		1	1			1	1	1	1	1	1	3
CO 3		1	1			1	1	1	1	1	1	3
CO 4		1	1			1	1	1	1	1	1	3
CO 5		1	1			1	2	1	2	1	1	3

1. **UNIT I: FOOD AND FOOD GROUPS:** Introduction to foods, food groups, Identifying locally available foods and plant nutrients. Nutrients and its variety. Cooking methods, effects of cooking on nutritive value of foods, while preparation and preservation of foods, cooking utensils & instruments. Synergy between foods, Do and Don'ts while cooking. Science behind foods.Food allergies, food poisoning, food safety standards.

2. **UNIT II: NUTRIENTS AND NUTRITION:** Nutrition through life cycle, RDA intake for all age groups. Nutrition in disease – Malnutrition (under & over), other diseases. Adulteration of foods & Food additives. Packaging and labeling of foods, certification, logo & symbols.

3. **UNIT III: INTRODUCTION TO FOOD BIOTECHNOLOGY:** Future foods- Organic foods and genetically modified foods, Fortification of foods, bio fortification of foods, value addition of foods, functional foods, nutraceuticals, weaning foods/supplementary. Processing and preservation of foods, applications of food technology in daily life, and your prospects associated with food industry – Nanoparticles, biosensors, advanced research.

Reference Books:

- C. Gopalanetal, **Nutritive Value of Indian Foods**, National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, 2017.
- B.SriLakhmi, **Dietetics**, New age international, 2015.
- N, ShakuntalaManay, M. Shadaksharaswamy, **Foods Facts and Principles**, New Age International, New Delhi, 2008.

- Sumati.RMudamri, and M.V.Rajagopal, **Fundamental of foods, Nutrition and DietTherapy**, New Age International, New Delhi, 2008.

15MAL101 MALAYALAM I 1 0 2 2

Course Objectives:

To teach Malayalam for effective communication in different spheres of life:- Social context , Education, Research & Media

Course Outcome : After the completion of the course the student will be able to:

CO1	Understand and inculcate philosophical thoughts and practices
CO2	Understand and appreciate the post modern trends of literature.
CO3	Analyse the literary texts and comprehend the cultural diversity of Kerala
CO4	Distinguish the different genres in Malayalam literature
CO5	Demonstrate the ability to effectively communicate in Malayalam

CO-PO Mapping Mapping of course outcomes with program outcomes:

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

Unit 1

Ancient poet trio:*Adhyatmaramayanam,LakshmanaSwanthanam (Lines: valsasoumitre… mungikidakayal),*Ezhuthachan -Medieval period classics – *Jnanappana(Lines: kalaminnu… vilasangalingane*),Poonthanam.

Unit 2
Modern Poet trio: *EnteGurunathan,* VallatholNarayanaMenon- Critical analysis of the poem.

Unit 3
Short stories from period 1/2/3:*Poovanpazham*-VaikaomMuhammedBasheer-Literary & Cultural figures of Kerala and about their literary contributions.
Unit 4

Literary Criticism: *BharathaParyadanam-VyasanteChiri*–Ithihasa studies-KuttikrishnaMararu-Outline of literary Criticism in Malayalam Literature-Introduction to KuttikrishnaMararu& his outlook towards literature &life.

Unit 5

Error-freeMalayalam: **1**.Language; **2**.Clarity of expression; **3**.Punctuation-Thettillatha
Malayalam – Writing-**a**. Expansion of ideas; **b**.PrecisWriting; **c**. Essay Writing; **d**.Letter writing; **e**.RadioSpeech;**f**.Script/Feature/Script
Writing;**g**.NewsEditing;**h**.Advertising;**i.**Editing;j.EditorialWriting;**k**.Critical appreciation of literary works (Any one or two as an assignment).

REFERENCES:

1. Prof. PanmanaRamachandranNair(Edited),*Thunjanpadhanangal*, Current Books, 2012.
2. Prof. G.Balakrishnan Nair,.*JnanappanayumHarinamaKeerthanavum*, N.B.S, 2005.
3..Dr. M.N.Karasseri,*BasheerintePoonkavanam*, D.C.Books, 2008.
4 Prof. M.N.Vijayan, *MarubhoomikalPookkumbol*,D.C.Books, 2010.
5..Prof. M.ThomasMathew,*LavanyanubhavathinteYukthisasthram*, Kerala Sahitya Academy, 2006.
6. Dr. .M.Leelavathy,*KavithaSahityacharitram*, Kerala Sahitya Academy, 1996.
7. ThayattuSankaran, *VallatholNavayugathinteKavi*,VallatholVidyapeetham

15MAL111 MALAYALAM II 1 0 2 2

Course Objectives

- To appreciate the aesthetics and understand the cultural implications in Malayalam Literature
- To enhance creative thinking in Malayalam
- To equip the students to read and write effectively in Malayalam
- To acquire pronunciation skills

Course Outcome:

After the completion of the course the student will be able to:

CO1	Understand the different cultural influences in linguistic translation
CO2	Identify and appreciate the Romantic elements of modern literature
CO3	Analyze the genre of autobiographical writing
CO4	Critically evaluate the significance of historical, political and socio cultural aspects in literature
CO5	Demonstrate good writing skills in Malayalam

CO-PO Mapping Mapping of course outcomes with program outcomes:

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

Unit1

Ancient poet trio: *Kalayanasougandhikam,(Lines: kallummarangalum… namukkennarikavrikodara)*,KunjanNambiar - Critical analysis of his poetry-Ancient Drama: *Kerala Sakunthalam* (Act 1), Kalidasan (Transilated by Attor Krishna Pisharody).

Unit 2

Modern/romantic/contemporary poetry: *Manaswini*, Changampuzha Krishna Pillai –Romanticism – modernism.

Unit 3

Anthology of short stories from period 3/4/5: *NinteOrmmayku*, M.T.Vasudevan Nair-literary contributions of his time.

Unit 4

Partof an autobiography/travelogue: *KannerumKinavum*, Chapter: Valarnnuvarunnoratmavu, V.T.Bhattathirippadu-Socio-cultural literature-historical importance.

Unit 5

Error-free Malayalam-**1**.Language; **2**.Clarity of expression; **3**.Punctuation-Thettillatha Malayalam-Writing-**a**.Expansion of ideas;**b**.PrécisWriting;**c.** Essay Writing; **d**.Letter writing;**e**.RadioSpeech;**f**.Script/Feature/ScriptWriting;**g**.NewsEditing;**h.**Advertising;**i**.Editing; **j**.EditorialWriting;**k**.Critical appreciation of literary works (Any one or two as an assignment).

REFERENCES:

1. Prof.P.K.NarayanaPillai.,(SahityaPanchanan), *Vimarsanathrayam,* Kerala Sahitya Academy,2000.

2. Prof.M.P. SankunniNair.,*ChathravumChamaravum,* D.C.Books, 2004.

3.Prof.M.K.Sanu, *Changampuzha: Nakshatrangalude Snehabhajanam*,N.B.S.,1989.

4. Prof.S.GupthanNair,*AsthiyudePookkal*, D.C Books.2005.

5. Prof. PanmanaRamachandranNair,*ThettillathaMalayalam,Sariyumthettum etc*., D.C.Book, 2006.

6. Prof.M. Achuthan, *Cherukatha-Innale, innu*, National Book Stall, 1998.

7. Prof.N.KrishnaPillai,*KairaliyudeKatha*,National Book Stall, 2001.

15TAM101 **TAMIL I** **2 0 0 2**

Course Objectives

- To introduce the students to different literature- Sangam literature, Epics, Bhakthi literatureandmodern literature.
- To improve their ability tocommunicate with creative concepts, and also to introduce them to the usefulness of basicgrammaticalcomponents in Tamil.

Course Outcomes

CO 1: To understand the Sangam literature
CO 2: To understand the creative literature
CO 3: To understand the literary work on religious scriptures
CO 4: To improve the communication and memory skills
CO 5: To understand the basic grammar components of Tamil language and their usage and applications.
CO 6: Understand creative writing aspects and apply them.

CO-PO Mapping

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

Syllabus

Unit1

The history ofTamilliterature: Nāṭṭupuṟap pāṭalkaḷ, kataikkaḷ, paḷamoḻikaḷ - ciṟukataikaḷ tōṟṟamum vaḷarcciyum,
ciṟṟilakkiyaṅkaḷ: Kaliṅkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ paḷḷu 35.
Kāppiyaṅkaḷ: Cilappatikāram – maṇimēkalai naṭaiyiyal āyvu maṟṟum aimperum – aiñciṟuṅ kāppiyaṅkaḷ toṭarpāṉa ceytikaḷ.

Unit 2

tiṇai ilakkiyamum nītiyilakkiyamum - patiṉeṇkīḻkkaṇakku nūlkaḷ toṭarpāṉa piṟa ceytikaḷ - tirukkuṟaḷ (aṉpu, paṇpu, kalvi, oḻukkam, naṭpu, vāymai, kēḷvi, ceynaṉṟi, periyāraittuṇakkōṭal, viḻippuṇarvu pēṉṟa atikārattil

uḷḷa ceytikaḷ.
Aṟanūlkaḷ: Ulakanīti (1-5) – ēlāti (1,3,6). - Cittarkaḷ: Kaṭuveḷi cittar pāṭalkaḷ (āṉantak kaḷippu –1, 4, 6, 7, 8), marrum akappēy cittar pāṭalkaḷ (1-5).

Unit 3

tamiḻ ilakkaṇam: Vākkiya vakaikaḷ – taṉviṉai piṟaviṉai – nērkkūrru ayaṟkūrru

Unit 4

tamiḻaka aṟiñarkaḷiṉ tamiḻ toṇṭum camutāya toṇṭum: Pāratiyār, pāratitācaṉ, paṭṭukkōṭṭai kalyāṇacuntaram, curatā, cujātā, ciṟpi, mēttā, aptul rakumāṉ, na.Piccaimūrtti, akilaṉ, kalki, jī.Yū.Pōp, vīramāmuṉivar, aṇṇā, paritimāṟ kalaiñar, maṟaimalaiyaṭikaḷ.

Unit 5

tamiḻ moḻi āyvil kaṇiṉi payaṉpāṭu. - Karuttu parimārram - viḻampara moḻiyamaippu – pēccu - nāṭakam paṭaippu - ciṟukatai, katai, putiṉam paṭaippu.

Textbooks:

- http:/Www.tamilvu.trg/libirary/libindex.htm.
- http:/Www.tunathamizh.tom/2013/07/blog0post_24.html
- Mu.Varatarācaṉ "tamiḻ ilakkiya varalāṟu" cāhitya akaṭemi papḷikēṣaṉs, 2012
- nā.Vāṉamāmalai "paḻaṅkataikaḷum, paḻamoḻikaḷum" niyū ceñcuri puttaka veḷiyīṭṭakam, 1980,2008
- nā.Vāṉamāmalai, "tamiḻar nāṭṭuppāṭalkaḷ" niyū ceñcuri puttaka veḷiyīṭṭakam 1964,2006
- poṉ maṇimāṟaṉ "aṭōṉ tamiḻ ilakkaṇam "aṭōṉ papḷiṣiṅ kurūp, vañciyūr, tiruvaṉantapuram, 2007.

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15TAM111 **TAMIL II** **2 0 0 2**

Course Objectives

- To learn the history ofTamilliterature.
- To analyze different styles of Tamil Language.
- To strengthen thecreativity in communication, Tamilbasicgrammar and use of computer on Tamil Language.

Course Outcomes

CO 1: Understand the history of Tamil literature.

CO 2: Apply practical and comparative analyses on literature.
CO 3: Understand thinai literature, literature on justice, Pathinenkeelkanaku literature.
CO 4: Understand the tamil scholars' service to Tamil language and society.
CO 5: Understand components of Tamil grammar and its usage
CO 6: Understand creative writing aspects and apply them

CO-PO Mapping

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

Syllabus

Unit 1

The history ofTamilliterature: Nāṭṭupuṟap pāṭalkaḷ, kataikkaḷ, paḻamoḻikaḷ - ciṟukataikaḷ tōṟṟamum vaḷarcciyum,
ciṟṟilakkiyaṅkaḷ: Kaliṅkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ paḷḷu 35.
Kāppiyaṅkaḷ: Cilappatikāram – maṇimēkalai naṭaiyiyal āyvu maṟṟum aimperum – aiñciṟuṅ kāppiyaṅkaḷ toṭarpāṉa ceytikaḷ.

Unit 2

tiṇai ilakkiyamum nītiyilakkiyamum - patiṉeṇkīḻkkaṇakku nūlkaḷ toṭarpāṉa piṟa ceytikaḷ - tirukkuṟaḷ (aṉpu, paṇpu, kalvi, oḻukkam, naṭpu, vāymai, kēḷvi, ceynaṉṟi, periyāraittuṇakkōṭal, viḻippuṇarvu pēṉṟa atikārattil uḷḷa ceytikaḷ.
Aṟanūlkaḷ: Ulakanīti (1-5) – ēlāti (1,3,6). - Cittarkaḷ: Kaṭuveḷi cittar pāṭalkaḷ (āṉantak kaḷippu –1, 4, 6, 7, 8), maṟṟum akappēy cittar pāṭalkaḷ (1-5).

Unit 3

tamiḻ ilakkaṇam: Vākkiya vakaikaḷ – taṉviṉai piṟaviṉai – nērkkūṟṟu ayaṟkūṟṟu

Unit 4

tamiḻaka aṟiñarkaḷiṉ tamiḻ toṇṭum camutāya toṇṭum: Pāratiyār, pāratitācaṉ, paṭṭukkōṭṭai kalyāṇacuntaram, curatā, cujātā, ciṟpi, mēttā, aptul rakumāṉ, na.Piccaimūrtti, akilaṉ, kalki, jī.Yū.Pōp, vīramāmuṉivar, aṇṇā, paritimāṟ kalaiñar, maṟaimalaiyaṭikaḷ.

Unit 5

tamiḻ moḻi āyvil kaṇiṉi payaṉpāṭu. - Karuttu parimārram - viḷampara moḻiyamaippu – pēccu - nāṭakam paṭaippu - ciṟukatai, katai, putiṉam paṭaippu.

Text Books / References

http:/Www.tamilvu.trg/libirary/libindex.htm.
http:/Www.tunathamizh.tom/2013/07/blog0post_24.html
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nā.Vāṉamāmalai "paḻaṅkataikaḷum, paḻamoḻikaḷum" niyū ceñcuri puttaka veḷiyīṭṭakam, 1980,2008
nā.Vāṉamāmalai, "tamiḻar nāṭṭuppāṭalkaḷ" niyū ceñcuri puttaka veḷiyīṭṭakam 1964,2006
poṉ maṇimāṟaṉ "aṭōṉ tamiḻ ilakkaṇam "aṭōṉ papḷiṣiṅ kurūp, vañciyū