HINDUSTHAN COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institution, Affiliated to Anna University, Chennai
Approved by AICTE, New Delhi & Accredited by NAAC with 'A' Grade)
Coimbatore – 641 032

B.E. AERONAUTICAL ENGINEERING

HINDUSTHAN EDUCATIONAL AND CHARITABLE TRUST

HICET

Curriculum & Syllabus

2019-2020

CHOICE BASED CREDIT SYSTEM

Department of Aeronautical Engineering

Vision of the Institute

To become a premier institution by producing professionals with strong technical knowledge, innovative research skills, and high ethical values

Mission of the Institute

IM1: To provide academic excellence in technical education through novel teaching methods

IM2: To empower students with creative skills and leadership qualities

IM3: To produce dedicated professionals with social responsibility

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Vision of the Department

To be a global player and prepare the students with knowledge, skills, and ethics for their successful deployment in Aeronautical Engineering.

Mission of the Department

DM1: To nurture the students technically based on current trends and opportunities in the global Aerospace industry.

DM2: To develop the students as innovative engineers to address the contemporary issues in the Aeronautical field.

DM3: To inculcate professional and social responsibility based on an innate ethical value system.

Program Educational Objectives (PEOs) of the Department

PEO1: Graduates shall exhibit their sound theoretical and practical knowledge with skills for successful employment, advanced education, research, and entrepreneurial endeavors.

PEO2: Graduates shall establish deep-rooted mastering abilities, professional ethics, and communication alongside business abilities and initiative through lifelong learning experiences.

PEO3: Graduates shall become leaders and innovators by devising engineering solutions to care for modern society.

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Program Outcomes (POs)

PO1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis	Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics	Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice.
PO9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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Program Specific Outcomes (PSOs)

The graduates will be able to

PSO1: Apply the knowledge of aerodynamics, structures, propulsion, avionics, and aircraft maintenance to give solutions for complex engineering problems.

PSO2: Use progressive methodology and tools involving design, analyze, and experiment in aircraft design.

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DETAILS OF CHANGES CARRIED OUT IN CURRICULUM & SYLLABUS

CBCS PATTERN

UNDERGRADUATE PROGRAMMES

B.E. AERONAUTICAL ENGINEERING (UG)

REGULATION-2016 & 2019

REGULATION-2019

For the students admitted during the academic year 2019-2020 and onwards
SEMESTER I

S.No.	Course Code	Course Title	Course category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1.	19HE1101	Technical English	HS	2	1	0	3	25	75	100
2.	19MA1102	Calculus and linear algebra	BS	3	1	0	4	25	75	100
THEORY & LAB COMPONENT										
3.	19PH1151	Applied Physics	BS	2	0	2	3	50	50	100
4.	19CY1151	Chemistry for Engineers	BS	2	0	2	3	50	50	100
5.	19CS1151	Python Programming and Practices	ES	2	0	2	3	50	50	100
6.	19ME1152	Engineering Drawing	ES	1	0	4	3	25	75	100
PRACTICAL										
7.	19HE1071	Value Added Course 1: Language Competency Enhancement Course-I	HS	0	0	2	1	100	0	100
8.	19MC1191	Induction Program	MC	0	0	0	0	0	0	0
			Total:	**12**	**2**	**12**	**20**	**325**	**375**	**700**

SEMESTER II

S.No.	Course Code	Course Title	Course category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1.	19HE2101	Business English for Engineers	HS	2	1	0	3	25	75	100
2.	19MA2101	Differential equations and complex variables	BS	3	1	0	4	25	75	100
3.	19EE2103	Basic of Electrical and Electronics Engineering	ES	3	0	0	3	25	75	100
4.	19ME2101	Engineering Mechanics	ES	3	0	0	3	25	75	100
THEORY & LAB COMPONENT										
5.	19PH2151	Material Science	BS	2	0	2	3	50	50	100
6.	19CY2151	Environmental Studies	BS	2	0	2	3	50	50	100
PRACTICAL										
7.	19HE2071	Language Competency Enhancement Course-II	HS	0	0	2	1	100	0	100
8.	19ME2001	Engineering Practices Laboratory	ES	0	0	4	2	50	50	100
		Total:		**15**	**2**	**10**	**22**	**350**	**450**	**800**

REGULATION - 2016

For the students admitted during the academic year 2018-2019 and onwards

SEMESTER III

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1.	16MA3103	Fourier Analysis and Statistics	3	1	0	4	25	75	100
2.	16AE3201	Aero Engineering Thermodynamics	3	0	0	3	25	75	100
3.	16AE3202	Solid Mechanics	3	0	0	3	25	75	100
4.	16AE3203	Engineering Fluid Mechanics	3	0	0	3	25	75	100
5.	16AE3204	Elements of Aeronautics	3	0	0	3	25	75	100
6.	16AE3205	Aircraft Systems and Instruments	3	0	0	3	25	75	100
PRACTICAL									
7.	16AE3001	Fluid mechanics and Thermodynamics Lab	0	0	4	2	50	50	100
8.	16AE3002	Aircraft component Drawing Laboratory	0	0	4	2	50	50	100
		Total :	**18**	**1**	**8**	**23**	**250**	**550**	**800**

SEMESTER IV

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16MA4107	Numerical Methods	3	1	0	4	25	75	100
2	16AE4201	Aerodynamics	3	0	0	3	25	75	100
3	16AE4202	Mechanics of Machines	3	1	0	4	25	75	100
4	16AE4203	Gas Turbine Propulsion	3	0	0	3	25	75	100
5	16AE4204	Aircraft Strength of Materials	3	1	0	4	25	75	100
6	16EI4231	Control Engineering	3	0	0	3	25	75	100
PRACTICAL									
7	16AE4001	Aerodynamics Laboratory	0	0	4	2	50	50	100
8	16AE4002	Aircraft Strength of Materials Laboratory	0	0	4	2	50	50	100
		Total:	**18**	**3**	**8**	**25**	**250**	**550**	**800**

For the students admitted during the academic year 2017-2018 and onwards

SEMESTER V

S.No	Course Code	Course Title	L	T	P	C	CIA	ESE	Total
1.	16AE5201	Aircraft Performance	3	0	0	3	25	75	100
2.	16AE5202	High Speed Aerodynamics	3	1	0	4	25	75	100
3.	16AE5203	Aircraft Structures	3	1	0	4	25	75	100
4.	16AE5204	Advanced Propulsion	3	0	0	3	25	75	100
5.	16AE5205	Aircraft General Engineering Maintenance and practice	3	0	0	3	25	75	100
6.	16AE53XX	Professional Elective – I	3	0	0	3	25	75	100
7.	16AE5001	Aircraft Structures Laboratory	0	0	4	2	50	50	100
8.	16AE5002	Propulsion Laboratory	0	0	4	2	50	50	100
		Total:	**18**	**2**	**8**	**24**	**250**	**550**	**800**

SEMESTER VI

S.No	Course Code	Course Title	L	T	P	C	CIA	ESE	Total
1	16AE6201	Aircraft stability and control	3	0	0	3	25	75	100
2	16AE6202	Finite Element Methods in Engineering	3	1	0	4	25	75	100
3	16AE6203	Composite Materials and Structures	3	0	0	3	25	75	100
4	16AE63XX	Professional Elective – II	3	0	0	3	25	75	100
5	16AE6401	Open Elective - I	3	0	0	3	25	75	100

6	16AE6001	Aircraft Design Project	0	0	4	2	50	50	100
7	16AE6002	Computer Aided Simulation Laboratory	0	0	4	2	50	50	100
8	16AE6003	Aircraft Systems Laboratory	0	0	4	2	50	50	100
9	16AE6801	Mini Project	0	0	6	3	50	50	100
		Total:	**15**	**1**	**18**	**25**	**325**	**575**	**900**

LIST OF PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVE-I

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16AE5301	Aircraft materials and processes	3	0	0	3	25	75	100
2	16AE5302	Heat Transfer	3	0	0	3	25	75	100
3	16AE5303	Boundary layer Theory	3	0	0	3	25	75	100
4	16AE5304	Principles of Management	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE-II

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16AE6301	Theory of Elasticity	3	0	0	3	25	75	100
2	16AE6302	Introduction to Cryogenics	3	0	0	3	25	75	100
3	16AE6303	Wind tunnel techniques	3	0	0	3	25	75	100
4	16AE6304	Aero Engine Maintenance and Repair	3	0	0	3	25	75	100

LIST OF OPEN ELECTIVES

OPEN ELECTIVE – 1

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16AE6401	Introduction to flight	3	0	0	3	25	75	100

For the students admitted during the academic year 2016-2017 and onwards
SEMESTER VII

S.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16AE7201	Avionics	3	0	0	3	25	75	100
2	16AE7202	Computational Fluid Dynamics	3	0	0	3	25	75	100

3	16AE73XX	Professional Elective-III	3	0	0	3	25	75	100
4	16AE73XX	Professional Elective-IV	3	0	0	3	25	75	100
5	16XX74XX	Open Elective-II	3	0	0	3	25	75	100
PRACTICAL									
6	16AE7001	Aero Engine and Airframe Laboratory	0	0	4	2	50	50	100
7	16AE7002	Avionics Laboratory	0	0	4	2	50	50	100
8	16AE7701	Internship / Industrial Training	0	0	0	2	0	100	100
9	16AE7702	Technical Publication	0	0	0	1	0	100	100
		Total :	**15**	**0**	**8**	**22**	**225**	**675**	**900**

SEMESTER VIII

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16AE83XX	Professional Elective-V	3	0	0	3	25	75	100
2	16AE83XX	Professional Elective-VI	3	0	0	3	25	75	100
PRACTICAL									
3	16AE8901	Project work	0	0	0	10	100	100	200
		Total	**6**	**0**	**0**	**16**	**150**	**250**	**400**

LIST OF PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVE-III

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16AE7301	Vibration and Elements of Aero Elasticity	3	0	0	3	25	75	100
2	16AE7302	Satellite Propulsion	3	0	0	3	25	75	100
3	16AE7303	Rockets and Missiles	3	0	0	3	25	75	100
4	16AE7304	Airframe Maintenance and Repair	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE-IV

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16AE7305	Experimental Stress analysis	3	0	0	3	25	75	100
2	16AE7306	Helicopter Theory	3	0	0	3	25	75	100
3	16AE7307	Aircraft Design	3	0	0	3	25	75	100
4	16AE7308	Engine system and control	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE-V

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16AE8301	Fatigue and Fracture	3	0	0	3	25	75	100
2	16AE8302	Professional Ethics	3	0	0	3	25	75	100
3	16AE8303	Space Mechanics	3	0	0	3	25	75	100
4	16AE8304	Aviation Management and Air safety	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE-VI

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16AE8305	Structural Dynamics	3	0	0	3	25	75	100
2	16AE8306	UAV Systems	3	0	0	3	25	75	100
3	16AE8307	Experimental Aerodynamics	3	0	0	3	25	75	100
4	16AE8308	Air Transportation control and Planning	3	0	0	3	25	75	100

LIST OF OPEN ELECTIVE

OPEN ELECTIVE –II

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16AE7402	Aerodynamics for Industrial Applications	3	0	0	3	25	75	100

CREDIT DISTRIBUTION

R-2016

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	27	25	23	25	24	25	22	16	**187**

R-2019

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	20	22	20	21	24	24	20	14	**165**

Chairman, Board of Studies

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SYLLABUS

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19HE1101	TECHNICAL ENGLISH	2	1	0	3

(COMMON TO ALL BRANCHES)

Course Objective

1. To facilitate students to communicate effectively with coherence.
2. To train the learners in descriptive communication.
3. To introduce professional communication.
4. To enhance knowledge and to provide the information on corporate environment.
5. To equip the trainers with the necessary skills on critical thinking.

Unit	Description	Instructional Hours
I	**Listening and Speaking** – Opening a conversation, maintaining coherence, turn taking, closing a conversation (excuse, general wishes, positive comments and thanks) **Reading** –Reading articles from newspaper, reading comprehension **Writing** Chart analysis, process description, Writing instructions **Grammar and Vocabulary-** Tenses, Regular and irregular verb, technical vocabulary	9
II	**Listening and Speaking-** listening to product description, equipment & work place (purpose, appearance, function) **Reading-** Reading technical articles **Writing-** Letter phrases, writing personal letters, **Grammar and Vocabulary-**articles, Cause & effect, Prepositions.	9
III	**Listening and Speaking- -** listening to announcements **Reading-** Reading about technical inventions, research and development **Writing-** Letter inviting a candidate for interview, Job application and resume preparation **Grammar and Vocabulary-** Homophones and Homonyms.	9
IV	**Listening and Speaking- -** Practice telephone skills and telephone etiquette (listening and responding, asking questions).**Reading-** Reading short texts and memos **Writing-** invitation letters, accepting an invitation and declining an invitation **Grammar and Vocabulary-** Modal verbs, Collocation, Conditionals, Subject verb agreement and Pronoun-Antecedent agreement.	9
V	**Listening and Speaking-** listening to technical group discussions and participating in GDs **Reading-** reading biographical writing - **Writing-** Proposal writing, Writing definitions, **Grammar and Vocabulary-** Abbreviation and Acronym, Prefixes & suffixes, phrasal verbs.	9
Total Instructional Hours		**45**

Course Outcome

CO1- Trained to maintain coherence and communicate effectively.
CO2- Practiced to create and interpret descriptive communication.
CO3- Introduced to gain information of the professional world.
CO4- acquired various types of communication and etiquette.
CO5- Taught to improve interpersonal and intrapersonal skills.

TEXT BOOKS:

T1- Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate", Cambridge University Press, 2014.
T2-Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, 2005.

REFERENCE BOOKS :

R1- Meenakshi Raman and Sangeetha Sharma, "Technical Communication-Principles and Practice", Oxford University Press, 2009.
R2- Raymond Murphy, "English Grammar in Use"-4th edition, Cambridge University Press, 2004
R3- Kamalesh Sadanan "A Foundation Course for the Speakers of Tamil-Part-I &II", Orient Blackswan.2010.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19MA1102	CALCULUS AND LINEAR ALGEBRA	3	1	0	4

Course Objective

1. Understand the concept of differentiation.
2. Evaluate the functions of several variables which are needed in many branches of engineering.
3. Understand the concept of double integrals.
4. Understand the concept of triple integrals.
5. Develop the skill to use matrix algebra techniques that is needed by engineers for practical applications.

Unit	Description	Instructional Hours
I	**DIFFERENTIAL CALCULUS** Rolle's Theorem – Lagrange's Mean Value Theorem- Maxima and Minima – Taylor's and Maclaurin's Theorem.	12
II	**MULTIVARIATE CALCULUS(DIFFERENTIATION)** Total derivatives - Jacobians– Maxima. Minima and Saddle points - Lagrange's method of undetermined multipliers – Gradient, divergence, curl and derivatives.	12
III	**DOUBLE INTEGRATION** Double integrals in Cartesian coordinates–Area enclosed by the plane curves (excluding surface area)– Green's Theorem (Simple Application) - Stoke's Theorem – Simple Application involving cubes and rectangular parellopiped.	12
IV	**TRIPLE INTEGRATION** Triple integrals in Cartesian co-ordinates – Volume of solids (Sphere, Ellipsoid, Tetrahedron) using Cartesian co-ordinates. Gauss Divergence Theorem – Simple Application involving cubes and rectangular parellopiped.	12
V	**MATRICES** Eigen values and Eigen vectors– Properties of Eigen values and Eigen vectors (without proof) - Cayley - Hamilton Theorem (excluding proof) - Reduction of a quadratic form to canonical form by orthogonal transformation.	12
	Total Instructional Hours	**60**

Course Outcome

CO1: Apply the concept of differentiation in any curve.
CO2: Identify the maximum and minimum values of surfaces.
CO3: Apply double integrals to compute area of plane curves.
CO4: Evaluation of triple integrals to compute volume of solids.
CO5: Calculate Eigen values and Eigen vectors for a matrix which are used to determine the natural frequencies (or Eigen frequencies) of vibration and the shapes of these vibrational modes.

TEXT BOOKS:

T1 - Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd.,New Delhi,2018.

T2 - Veerarajan T, "Engineering Mathematics", McGraw Hill Education(India) Pvt Ltd, New Delhi, 2016.

REFERENCE BOOKS :

R1- Thomas & Finney " Calculus and Analytic Geometry" , Sixth Edition.,Narosa Publishing House, New Delhi.

R2 - BaliN.P &ManishGoyal."ATextbookofEngineeringMathematics",8th Edition, Laxmi Pub. Pvt. Ltd. 2011.

R3 - Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19PH1151	APPLIED PHYSICS (COMMON TO ALL BRANCHES)	2	0	2	3

Course Objective
1. Enhance the fundamental knowledge in properties of matter
2. Analysis the oscillatory motions of particles
3. Extend the knowledge about wave optics
4. Gain knowledge about laser and their applications
5. Conversant with principles of optical fiber, types and applications of optical fiber

Unit	Description	Instructional Hours
I	**PROPERTIES OF MATTER** Elasticity – Hooke's law – Stress-strain diagram - Poisson's ratio – Bending moment – Depression of a cantilever – Derivation of Young's modulus of the material of the beam by Uniform bending theory and experiment. **Determination of Young's modulus by uniform bending method.**	6+3=9
II	**OSCILLATONS** Translation motion –Vibration motion – Simple Harmonic motion – Differential Equation of SHM and its solution –Damped harmonic oscillation - Torsion stress and deformations – Torsion pendulum: theory and experiment. **Determination of Rigidity modulus – Torsion pendulum.**	6+3=9
III	**WAVE OPTICS** Conditions for sustained Interference – air wedge and it's applications - Diffraction of light – Fresnel and Fraunhofer diffraction at single slit –Diffraction grating– Rayleigh's criterion of resolution power - resolving power of grating. **Determination of wavelength of mercury spectrum – spectrometer grating. Determination of thickness of a thin wire – Air wedge method.**	6+6=12
IV	**LASER AND APPLICATIONS** Spontaneous emission and stimulated emission – Population inversion – Pumping methods – Derivation of Einstein's coefficients (A&B) – Type of lasers – Nd:YAG laser and CO_2 laser- Laser Applications – Holography – Construction and reconstruction of images. **Determination of Wavelength and particle size using Laser.**	6+3=9
V	**FIBER OPTICS AND APPLICATIONS** Principle and propagation of light through optical fibers – Derivation of numerical aperture and acceptance angle – Classification of optical fibers (based on refractive index, modes and materials) – Fiber optical communication link – Fiber optic sensors – Temperature and displacement sensors.	6
	Total Instructional Hours	**45**

Course Outcome
CO1: Illustrate the fundamental properties of matter
CO2: Discuss the Oscillatory motions of particles
CO3: Analyze the wavelength of different colors
CO4: Understand the advanced technology of LASER in the field of Engineering
CO5: Develop the technology of fiber optical communication in engineering field

TEXT BOOKS:

T1 - Rajendran V. Applied Physics. Tata McGraw Hill Publishing Company Limited. New Delhi. 2017.
T2- Gaur R.K. and Gupta S.L.. Engineering Physics. 8th edition. Dhanpat Rai Publications (P) Ltd.. New Delhi. 2015.

REFERENCE BOOKS:

R1 -Arthur Beiser "Concepts of Modern Physics" Tata McGraw Hill. New Delhi – 2015.
R2 -M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company ltd., New Delhi. 2016.
R3 - Dr. G. Senthilkumar "Engineering Physics – I" VRB publishers Pvt Ltd.. 2016.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19CY1151	CHEMISTRY FOR ENGINEERS (COMMON TO ALL BRANCHES)	2	0	2	3

Course Objective

1. The boiler feed water requirements, related problems and water treatment techniques.
2. The principles of polymer chemistry and engineering applications of polymers and composites.
3. The principles of electrochemistry and with the mechanism of corrosion and its control.
4. The principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
5. The important concepts of spectroscopy and its applications.

Unit	Description	Instructional Hours
I	**WATER TECHNOLOGY** Hard water and soft water- Disadvantages of hard water- Hardness: types of hardness, simple calculations, estimation of hardness of water – EDTA method – Boiler troubles - Conditioning methods of hard water – External conditioning - demineralization process - desalination: definition, reverse osmosis – Potable water treatment – breakpoint chlorination. **Estimation of total, permanent and temporary hardness of water by EDTA.**	6 +3=9
II	**POLYMER & COMPOSITES** Polymerization – types of polymerization – addition and condensation polymerization – mechanism of free radical addition polymerization – copolymers – plastics: classification – thermoplastics and thermosetting plastics, preparation, Polymerization – types Polymerization – types of polymerization – addition and condensation polymerization – mechanism of free radical addition polymerization – copolymers – plastics: classification – thermoplastics and thermosetting plastics, preparation, properties and uses of commercial plastics – PVC, Bakelite – moulding of plastics (extrusion and compression); Composites: definition, types of composites – polymer matrix composites (PMC) –FRP	6
III	**ELECTROCHEMISTRY AND CORROSION** Electrochemical cells – reversible and irreversible cells - EMF- Single electrode potential – Nernst equation (derivation only) – Conductometric titrations. Chemical corrosion – Pilling – Bedworth rule – electrochemical corrosion – different types –galvanic corrosion – differential aeration corrosion – corrosion control – sacrificial anode and impressed cathodic current methods - protective coatings – paints – constituents and functions. **Conductometric titration of strong acid vs strong base (HCl vs NaOH).Conductometric titration (Mixture of strong acid and base).Conductometric precipitation titration using $BaCl_2$ and Na_2SO_4**	6+9 =15
IV	**ENERGY SOURCES AND STORAGE DEVICES** Introduction- nuclear energy- nuclear fission- controlled nuclear fission- nuclear fusion differences between nuclear fission and fusion- nuclear chain reactions- nuclear reactor power generator- classification of nuclear reactor- light water reactor- breeder reactor. Batteries and fuel cells: Types of batteries- alkaline battery- lead storage battery- lithium battery- fuel cell H_2 -O_2 fuel cell applications.	6
V	**ANALYTICAL TECHNIQUES** Beer-Lambert's law – UV-visible spectroscopy and IR spectroscopy – principles – instrumentation (block diagram only) – flame photometry – principle – instrumentation (block diagram only) – estimation of sodium by flame photometry – atomic absorption spectroscopy – principles – instrumentation (block diagram only) – estimation of nickel by atomic absorption spectroscopy. **Determination of iron content of the water sample using spectrophotometer.(1,10 phenanthroline / thiocyanate method).**	6+3
	Total Instructional Hours	**45**

Course Outcome

CO1: Differentiate hard and soft water and to solve the related problems on water purification and its significance in industries and daily life

CO2: Acquire the basic knowledge of polymers, composites and FRP and their significance.

CO3: Develop knowledge on the basic principles of electrochemistry and understand the causes of corrosion, its consequences to minimize corrosion to improve industrial design.

CO4: Develop knowledge about the renewable energy resources and batteries along with the need of new materials to improve energy storage capabilities.

CO5: Identify the structure and characteristics of unknown/new compound with the help spectroscopy.

TEXT BOOKS

T1 - P.C.Jain and Monica Jain. "Engineering Chemistry" Dhanpat Rai Pub. Co., New Delhi (2018).

REFERENCES

R1 - B.Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2012).

R2 - S.S.Dara "A Text book of Engineering Chemistry" S.Chand & Co. Ltd., New Delhi (2017).

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Programme	Course Code	Name of the Course	L	P	T	C
B.E.	19CS1151	PYTHON PROGRAMMING AND PRACTICES	2	0	2	3

Course Objective

1. To know the basics of algorithmic problem solving
2. To read and write simple Python programs
3. To develop Python programs with conditionals and loops and to define Python functions and call them
4. To use Python data structures — lists, tuples, dictionaries
5. To do input/output with files in Python

Unit	Description	Instructional Hours
I	**ALGORITHMIC PROBLEM SOLVING** Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.	9
II	**DATA, EXPRESSIONS, STATEMENTS** Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments. *Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.*	7+2(P)
III	**CONTROL FLOW, FUNCTIONS** Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. *Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.*	5+4(P)
IV	**LISTS, TUPLES, DICTIONARIES** Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; *Illustrative programs: selection sort, insertion sort, merge sort, histogram.*	3+6(P)
V	**FILES, MODULES, PACKAGES** Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages. *Illustrative programs: word count, copying file contents.*	5+4(P)
	Total Instructional Hours	**(29 + 16) 45**

Course Outcome

- CO1: Develop algorithmic solutions to simple computational problems
- CO2: Read, write, execute by hand simple Python programs
- CO3: Structure simple Python programs for solving problems and Decompose a Python program into functions
- CO4: Represent compound data using Python lists, tuples, dictionaries
- CO5: Read and write data from/to files in Python Programs.

TEXT BOOKS:

T1: Guido van Rossum and Fred L. Drake Jr. An Introduction to Python – Revised andupdated for Python 3.6.2, Shroff Publishers, First edition (2017).

T2: S. Annadurai, S.Shankar, I.Jasmine, M.Revathi, Fundamentals of Python Programming, Mc-Graw Hill Education (India) Private Ltd. 2019

REFERENCE BOOKS:

R1: Charles Dierbach, —Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

R2: Timothy A. Budd, —Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd., 2015

R3: Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	19ME1152	ENGINEERING DRAWING	1	0	4	3

Course Objective

1. To gain the knowledge of Engineer's language of expressing complete details about objects and construction of conics and special curves.
2. To learn about the orthogonal projections of straight lines and planes.
3. To acquire the knowledge of projections of simple solid objects in plan and elevation.
4. To learn about the projection of sections of solids and development of surfaces.
5. To study the isometric projections of different objects.

UNIT	DESCRIPTION	TOTAL HOURS
I	**PLANE CURVES** Importance of engineering drawing; drafting instruments; drawing sheets – layout and folding; Lettering and dimensioning. BIS standards, scales. Geometrical constructions. Engineering Curves Conic sections – Construction of ellipse, parabola and hyperbola by eccentricity method. Construction of cycloids and involutes of square and circle – Drawing of tangents and normal to the above curves.	12
II	**PROJECTIONS OF POINTS, LINES AND PLANE SURFACES** Introduction to Orthographic projections- Projection of points. Projection of straight lines inclined to both the planes. Determination of true lengths and true inclinations by rotating line method. Projection of planes (polygonal and circular surfaces) inclined to both the planes by rotating object method (First angle projections only).	12
III	**PROJECTIONS OF SOLIDS** Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is perpendicular and inclined to one plane by rotating object method.	12
IV	**SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES** Sectioning of simple solids with their axis in vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other – Obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids, cylinder and cone. Development of lateral surfaces of truncated solids.	12
V	**ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS** Isometric views and projections simple and truncated solids such as – Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions. Free hand sketching of multiple views from a pictorial drawing. Basics of drafting using AutoCAD software.	12
	TOTAL INSTRUCTIONAL HOURS	**60**

Course Outcome

CO1: Understand and interpret the engineering drawings in order to visualize the objects and draw the conics and special curves.
CO2: Draw the orthogonal projections of straight lines and planes.
CO3: Interpret the projections of simple solid objects in plan and elevation.
CO4: Draw the projections of section of solids and development of surfaces of solids.
CO5: Draw the isometric projections and the perspective views of different objects.

TEXT BOOK:

1. K.Venugopal, V.Prabu Raja, "Engineering Drawing, AutoCAD, Building Drawings", 5th Edition New Age International Publishers, New delhi 2016.
2. K.V.Natarajan, "A textbook of Engineering Graphics", Dhanlaksmi Publishers, Chennai.

REFERENCES:

1. Basant Agrawal and C.M.Agrawal, "Engineering Drawing", Tata McGraw Hill Publishing Company Limited,New Delhi 2008.
2. N.S. Parthasarathy, Vela Murali, "Engineering Drawing", Oxford University PRESS, India 2015.

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	19HE1071	VALUE ADDED COURSE-I LANGUAGE COMPETENCY ENHANCEMENT COURSE - I (COMMON TO ALL BRANCHES)	0	0	2	1

Topic No.	Description of the Experiments
1.	INTRODUCTION TO AERONAUTICAL ENGINEERING
2.	LEADERSHIP FOR ENGINEERS
3.	4G – NETWORK ESSNTIALS
4.	COMP. SCIENCE ESSENTIALS FOR SOFTWARE DEVELOPMENT
5.	INTRODUCTION ANALYTICS MODELLING
6.	MATERIAL SCIENCE AND ENGINEERING
	Total Marks 100

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19HE2101	BUSINESS ENGLISH FOR ENGINEERS	2	1	0	3

Course Objective

1. To introduce to business communication.
2. To train the students to react to different professional situations.
3. To make the learner familiar with the managerial skills
4. To empower the trainee in business writing skills.
5. To learn to interpret and expertise different content.

Unit	Description	Instructional Hours
I	**Listening and Speaking** – listening and discussing about programme and conference arrangement **Reading** –reading auto biographies of successful personalities **Writing** Formal & informal email writing, Recommendations **Grammar and Vocabulary-** Business vocabulary, Adjectives & adverbs	9
II	**Listening and Speaking-** listening to TED talks **Reading-**Making and interpretation of posters **Writing-** Business letters: letters giving good and bad news. Thank you letter. Congratulating someone on a success" **Grammar and Vocabulary-** Active & passive voice. Spotting errors (Tenses, Preposition, Articles)	9
III	**Listening and Speaking-**travel arrangements and experience **Reading-** travel reviews **Writing-** Business letters (Placing an order, making clarification & complaint letters). **Grammar and Vocabulary-** Direct and Indirect speech.	9
IV	**Listening and Speaking-** Role play- **Reading-** Sequencing of sentence **Writing-** Business report writing (marketing, investigating) **Grammar and Vocabulary-** Connectors, Gerund & infinitive	9
V	**Listening and Speaking-** Listen to Interviews & mock interview **Reading-** Reading short stories, reading profile of a company **- Writing-** Descriptive writing (describing one's own experience) **Grammar and Vocabulary-** Editing a passage(punctuation, spelling& number rules)	9
	Total Instructional Hours	**45**

Course Outcome

CO1- Introduced to different modes and types of business communication.
CO2- Practiced to face and react to various professional situations efficiently.
CO3- learnt to practice managerial skills.
CO4- Familiarized with proper guidance to business writing.
CO5- Trained to analyze and respond to different types of communication.

TEXT BOOKS:

T1 - Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate",Cambridge University Press, 2014.

T2- Ian Wood and Anne Willams. "Pass Cambridge BEC Preliminary", Cengage Learning press 2013.

REFERENCE BOOKS :

R1 -Michael Mc Carthy, "Grammar for Business", Cambridge University Press, 2009

R2- Bill Mascull, "Business Vocabulary in use: Advanced 2nd Edition", Cambridge University Press, 2009.

R3-Frederick T. Wood, "Remedial English Grammar For Foreign Students", Macmillan publishers, 1986.

V.T. Chairman - BoS AERO - KICET

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19MA2101	DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES	3	1	0	4

Course Objectives

1. Describe some methods to solve different types of first order differential equations.
2. Solve ordinary differential equations of certain types using Wronskian technique.
3. Use the effective mathematical tools for the solutions of partial differential equations.
4. Describe the construction of analytic functions and conformal mapping.
5. Illustrate Cauchy's integral theorem and calculus of residues.

Unit	Description	Instructional Hours
I	**FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS** Equations of the first order and of the first degree – Homogeneous equations – Exact differential equations – Linear equations – Equations reducible to the linear form – Benoulli's equation .	12
II	**ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER** Second order linear differential equations with constant and variable co-efficients – Cauchy – Euler equations – Cauchy – Legendre equation – Method of variation of paramers.	12
III	**PARTIAL DIFFERENTIAL EQUATIONS** Formation of partial differential equations by the elemination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations of the form f(p,q)=0. Clairaut's type : z = px+qy +f(p.q) – Lagrange's linear equation.	12
IV	**COMPLEX DIFFERENTIATION** Functions of complex variables – Analytic functions – Cauchy's – Riemann's equations and sufficient conditions (excluding proof) – Construction of analytic functions – Milne –Thomson's method – Conformal mapping w = A+z , Az, 1/z and bilinear transformations.	12
V	**COMPLEX INTEGRATION** Cauchy's integral theorem – Cauchy's integral formula –Taylor's and Laurent's series (statement only) –Residues - Cauchy's Residue theorem.	12
	Total Instructional Hours	**45+15**

Course Outcomes

CO1: Apply few methods to solve different types of first order differential equations.
CO2: Develop sound knowledge of techniques in solving ordinary differential equations.
CO3: Solve the Partial Differential Equations using various methods.
CO4: Infer the knowledge of construction of analytic functions and conformal mapping.
CO5: Evaluate real and complex integrals over suitable closed paths or contours.

TEXT BOOKS:

T1- Ravish R Singh, Mukul Bhatt, "Engineeing Mathematics", McGraw Hill education (India) Private Ltd.,Chennai,2017.
T2- Veerarajan T, "Engineering Mathematics", McGraw Hill Education(India) Pvt Ltd, New Delhi, 2016

REFERENCE BOOKS:

R1-BaliN.P &ManishGoyal,"ATextbookofEngineeringMathematics",8th Edition, Laxmi Pub. Pvt. Ltd. 2011.
R2- Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.
R3- Peter V. O'Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage learning,2012.
R4-Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley and Sons, 2006.
R5- Wylie & Barett, "Advanced Engineering Mathematics", McGraw Hill Education, 6th edition, 2003.

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Programme	Course Code	Name of the course	L	T	P	C
B.E.	19EE2103	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	3	0	0	3

Course Objectives

1 apply the basic laws used in Electrical circuits and the different components.
2 impart knowledge on construction and working of DC and AC machines.
3 provide knowledge on the fundamentals of semiconductor devices and their applications.
4 impart knowledge on digital electronics and its principles.
5 To develop block diagrams for TV, satellite and optical fiber communications.

Unit	Description	Instructional Hours
I	**ELECTRICAL CIRCUITS AND MEASUREMENTS** Ohm's Law – Kirchoff's Laws – Steady State Solution of DC Circuits – Introduction to AC Circuits – RMS - Average Value for sine wave – Power and Power factor – Single Phase circuits. Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters). Dynamometer type Watt meters and Energy meters.	9
II	**FUNDAMENTALS OF ELECTRICAL MACHINES** Construction, Principle of Operation of DC Generators - EMF Equation - Construction, Principle of Operation of DC shunt and series Motors, Single Phase Transformer - EMF Equation, Single phase induction motor: capacitor start - capacitor run – Construction, Principle of Operation of Three Phase Induction Motor – Applications - (Qualitative Approach only).	9
III	**SEMICONDUCTOR DEVICES AND APPLICATIONS** Characteristics of PN Junction Diode – Zener Diode and its Characteristics – Zener Effect – Half wave and Full wave Rectifiers – Voltage Regulation. Bipolar Junction Transistor (BJT) – CB, CE, CC Configurations and Characteristics – FET – Characteristics.	9
IV	**DIGITAL ELECTRONICS** Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops (RS, JK, T & D), A/D and D/A Conversion (Dual Slope, SAR, Binary-weighted and R-2R).	9
V	**FUNDAMENTALS OF COMMUNICATION ENGINEERING** Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations – TV, Satellite and Optical Fibre Communications (Block Diagram Approach only).	9
	Total Instructional Hours	**45**

Course Outcomes

CO1 Apply the KVL and KCL in Electrical circuits.
CO2 Explain the constructional features of AC and DC machines.
CO3 Identify electronics components and use of them to design circuits.
CO4 Use appropriate logic gates in circuit design.
CO5 Construct block diagram and explain TV, satellite and optical fibre communication systems.

TEXT BOOKS:

T1 Muthusubramanian R, Salivahanan S and Muraleedharan K A, "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill, Eighteenth Reprint, 2014.
T2 Mittle N., "Basic Electrical Engineering", Tata McGraw Hill Edition, New Delhi, 1990.

REFERENCE BOOKS:

R1 Premkumar N, "Basic Electrical and Electronics Engineering", Anuradha Publishers, 2018.
R2 Mehta V K, "Principles of Electronics", S.Chand & Company Ltd, 1994.
R3 Nagsarkar T K and Sukhija M S, "Basics of Electrical Engineering", Oxford press 2005.

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Programme	Course Code	Name Of The Course	L	T	P	C
B.E.	19ME2101	ENGINEERING MECHANICS	3	0	0	3

Course Objective

1. To understand basic concepts and force systems in a real world environment.
2. To understand the static equilibrium of particles and rigid bodies both in two dimensions.
3. To understand the moment of surfaces and solids.
4. To understand the effect of static friction on equilibrium.
5. To understand the dynamic equilibrium equation.

UNIT	DESCRIPTION	TOTAL HOURS
I	**STATICS OF PARTICLES** Introduction to engineering mechanics - Classifications, force vector, Law of mechanics, System of forces, transmissibility, Force on a particle – resultant of two forces and several concurrent forces – resolution of a force – equilibrium of a particle — forces in space – equilibrium of a particle in space.	9
II	**EQUILIBRIUM OF RIGID BODIES** Free body diagram, moment of a force – varignon's theorem – moment of a couple – resolution of a force and a couple. Support reactions of the beam.	9
III	**CENTROID, CENTRE OF GRAVITY AND MOMENT OF INERTIA** Centroids of simple plane areas, composite areas, determination of moment of inertia of composite plane figures, polar moment of inertia-radius of gyration – mass moment of inertia of simple solids.	9
IV	**FRICTION** Laws of dry friction – angles of friction- angle of repose-coefficient of static and kinetic friction — Friction in inclined plane, Ladder friction, Screw friction– rolling resistance – belt friction.	9
V	**DYNAMICS OF PARTICLES** Rectilinear and Curve linear motion, -Newton's II law – D'Alembert's principle- Energy - potential energy kinetic energy-conservation of energy-work done by a force - work energy method, Impulse momentum method, Impact of bodies, Translation and rotation of the particles.	9
	TOTAL INSTRUCTIONAL HOURS	**45**

Course Outcome

CO1: Define and illustrate the basic concepts of force system.
CO2: Identify the resultant force and couple, support reactions of the beam.
CO3: Calculate the Centre of gravity and moment of inertia of an object.
CO4: Examine the friction force of particles and objects for Impending Motion.
CO5: Determine the Displacement, velocity and acceleration of particles and objects

TEXT BOOKS:

T1. F.P.Beer, and Jr. E.R.Johnston., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
T2. NH.Dubey, "Engineering Mechanics", Tata Mcraw Hill, New Delhi, 2016.

REFERENCE BOOKS:

1. R.C.Hibbeller, and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.
2. S.S.Bhavikatti, and K.G.Rajashekarappa, "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.
3. P. Jaget Babu, "Engineering Mechanics", Pearson Publisher, India Ltd. 2016.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19PH2151	MATERIAL SCIENCE	2	0	2	3

Course Objective

1. Acquire fundamental knowledge of semiconducting materials which is related to the engineering program
2. Extend the knowledge about the magnetic materials
3. Explore the behavior of super conducting materials
4. Gain knowledge about Crystal systems
5. Understand the importance of ultrasonic waves

Unit	Description	Instructional Hours
I	**SEMICONDUCTING MATERIALS** Introduction – Intrinsic semiconductor – Compound and elemental semiconductor - direct and indirect band gap of semiconductors. Carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination. Optical properties of semiconductor – Light through optical fiber(Qualitative). **Determination of band gap of a semiconductor. Determination of acceptance angle and numerical aperature in an optical fiber.**	6+6=12
II	**MAGNETIC MATERIALS** Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – anti ferromagnetic materials – Ferrites and its applications. **B – H curve by Magnetic hysteresis experiment.**	6+3=9
III	**PERCONDUCTING MATERIALS** Superconductivity : properties(Messiner effect, effect of magnetic field, effect of current and isotope effects) – Type I and Type II superconductors –High Tc superconductors – Applications of superconductors –Cryotron and magnetic levitation.	6
IV	**CRYSTAL PHYSICS** Crystal systems - Bravais lattice - Lattice planes - Miller indices - Interplanar spacing in cubic lattice - Atomic radius, Coordination number and Packing factor for SC, BCC and FCC crystal structures.	6
V	**ULTRASONICS** Production – Magneto strictive generator – Piezoelectric generator – Determination of velocity using acoustic grating–Cavitations–Viscous force –co-efficient of viscosity. Industrial applications – Drilling and welding – Non destructive testing – Ultrasonic pulse echo system. **Determination of velocity of sound and compressibility of liquid – Ultrasonic wave. Determination of Coefficient of viscosity of a liquid –Poiseuille's method**.	6+6=12
	Total Instructional Hours	**45**

Course Outcome

CO1: Understand the purpose of acceptor or donor levels and the band gap of a semiconduct

CO2: Interpret the basic idea behind the process of magnetism and its applications in everyday

CO3: Discuss the behavior of super conducting materials

CO4: Illustrate the types and importance of crystal systems

CO5: Evaluate the production of ultrasonics and its applications in NDT

TEXT BOOKS:

T1 - Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.

T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2015.

REFERENCE BOOKS:

R1 -Arthur Beiser "Concepts of Modern Physics" Tata McGraw Hill, New Delhi – 2015

R2 -M. N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company ltd., New Delhi, 2016.

R3 - Dr. G. Senthilkumar "Engineering Physics II" VRB publishers Pvt Ltd., 2016

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19CY2151	ENVIRONMENTAL STUDIES	2	0	2	3

Course Objective

1. The natural resources, exploitation and its conservation
2. The importance of environmental education, ecosystem and biodiversity.
3. The knowledge about environmental pollution – sources, effects and control measures of environmental pollution.
4. Scientific, technological, economic and political solutions to environmental problems.
5. An awareness of the national and international concern for environment and its protection.

Unit	Description	Instructional Hours
I	**NATURAL RESOURCES** Renewable and Non renewable resources - Forest resources: Use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forests and tribal people - Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture – Energy resources: Renewable and non renewable energy sources– Solar energy and wind energy - role of an individual in conservation of natural resources.	6
II	**ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY** Importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem - energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the forest and ponds ecosystem – Introduction to biodiversity definition: types and value of biodiversity – hot-spots of biodiversity – threats to biodiversity– endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.	6
III	**ENVIRONMENTAL POLLUTION** Definition – causes, effects and control measures of: Air pollution- Water pollution – Water quality parameters- Soil pollution - Noise pollution- Nuclear hazards – role of an individual in prevention of pollution.**Determination of Dissolved Oxygen in sewage water by Winkler's method. Estimation of alkalinity of water sample by indicator method.Determination of chloride content of water sample by argentometric method.**	6+9=15
IV	**SOCIAL ISSUES AND THE ENVIRONMENT** From unsustainable to sustainable development – urban problems related to energy- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- Municipal solid waste management. Global issues – Climatic change, acid rain, greenhouse effect and ozone layer depletion – Disaster Management – Tsunami and cyclones. **Determination of pH in beverages.**	6+3=9
V	**HUMAN POPULATION AND THE ENVIRONMENT** Population growth, variation among nations – population explosion – family welfare programme – environment and human health – effect of heavy metals – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- GIS-remote sensing-role of information technology in environment and human health. **Estimation of heavy metal ion (copper) in effluents by EDTA.**	6+3=9
	Total Instructional Hours	**45**

Course Outcome

CO1: Develop an understanding of different natural resources including renewable resources.
CO2: Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO3: Understand the causes of environmental pollution and hazards due to manmade activities.
CO4: Demonstrate an appreciation for need for sustainable development and understand the various Social issues and solutions to solve the issues.
CO5: Gain knowledge about the importance of women and child education and know about the existing technology to protect environment

TEXT BOOKS:

T1- Anubha Kaushik and C. P. Kaushik, "Perspectives in Environmental studies", Sixth edition, New Age International Publishers, New Delhi, 2019.

T2 – S.Annadurai and P.N. Magudeswaran, "Environmental studies", Cengage Learning India Pvt.Ltd. Delhi, 2018

REFERENCES:

R1 – Erach Bharucha, "Textbook of environmental studies" University Press (I) Pvt.ltd. Hyderabad, 2015

R2 - G.Tyler Miller, Jr and Scott E. Spoolman"Environmental Science" Thirteenth Edition, Cengage Learning, 2010.

R3 - Gilbert M. Masters and Wendell P. Ela "Introduction to Environmental Engineering and Science", 3rd edition, Pearson Education, 2013.

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	19HE2071	LANGUAGE COMPETENCY ENHANCEMENT COURSE- II	0	0	2	1

(COMMON TO ALL BRANCHES)

Course Objective

- ✓ To improve communication skills and Professional Grooming.
- ✓ To impart deeper knowledge of English Language and its practical application in different facets of life.
- ✓ To equip the techniques of GD, Public Speaking, debate etc.

Unit	Description	Instructional Hours
I	**Listening** Listening for gist and respond – Listen for detail using key words to extract specific meaning – listen for phonological detail – Listen and identify the main points for short explanations and presentation.	3
II	**Reading** Strategies for effective reading – read and recognize different text types – Genre and Organization of Ideas – Quantifying reading – reading to comprehend – Interpreting sentences – contrasting, summarizing or approximating	3
III	**Speaking** Speak to communicate – Make requests and ask questions to obtain personal information – use stress and intonation – articulate the sounds of English to make the meaning understood – speaking to present & Interact – opening and closing of speech.	3
IV	**Writing** Plan before writing – develop a paragraph: topic sentences, supporting sentences – write a descriptive paragraph – elements of good essay – descriptive, narrative, argumentative – writing emails – drafting resumes – project writing – convincing proposals.	3
V	**Language Development** Demonstration at level understanding of application of grammar rules – revision of common errors : preposition, tenses, conditional sentences –reference words – pronouns and conjunctions.	3
	Total Instructional Hours	**15**

Course Outcome

CO1- Introduced to different modes and types of communication.
CO2- Practiced to face and react to various professional situations efficiently.
CO3- learnt to practice managerial skills.
CO4- Familiarized with proper guidance to writing.
CO5- Trained to analyze and respond to different types of communication.

REFERENCE BOOKS:

1. Verbal Ability and Reading Comprehension by Arun Sharma,9th edition,Tata Mc graw Hill
2. Word Power Made Easy by Norman Lewis,– Print, 1 June 2011.
3. High School English Grammar by Wren and Martin,S.CHAND Publications, 1 January 2017.
4. Practical course in Spoken English by J.K. Gangal,PHI Learning , Second edition, 1 January 2018.

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Programme	COURSE CODE	Name of the Course	L	T	P	C
B.E.	19ME2001	ENGINEERING PRACTICES LABORATORY	0	0	4	2

OBJECTIVES:

To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical and Electrical Engineering.

GROUP A (CIVIL & MECHANICAL)

S.No Description of the Experiments

CIVIL AND MECHANICAL ENGINEERING PRACTICES

1. Preparation of Single pipe line and Double pipe line connection by using valves, taps, couplings, unions, reducers and elbows.
2. Arrangement of bricks using English bond for 1brick thick wall and 11/2 brick thick wall for right angle corner junction.
3. Arrangement of bricks using English bond for 1brick thick wall and 11/2 brick thick wall for T junction.
4. Preparation of arc welding of Butt joints, Lap joints and Tee joints.
5. Practice on sheet metal Models– Trays and funnels
6. Hands-on-exercise in wood work, joints by sawing, planning and cutting.
7. Practice on simple step turning, taper turning and drilling.
8. Demonstration on Smithy operation.
9. Demonstration on Foundry operation.
10. Demonstration on Power tools.

GROUP B (ELECTRICAL)

S.No Description of the Experiments

ELECTRICAL ENGINEERING PRACTICES

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring.
4. Measurement of Electrical quantities – voltage, current, power & power factor in single phase circuits.
5. Measurement of energy using single phase energy meter.
6. Soldering practice using general purpose PCB.
7. Measurement of Time, Frequency and Peak Value of an Alternating Quantity using CRO and Function Generator.
8. Study of Energy Efficient Equipment's and Measuring Instruments.

Total Practical Hours 45

COURSE OUTCOME

CO1: Fabricate wooden components and pipe connections including plumbing works.
CO2: Fabricate simple weld joints.
CO3: Fabricate different electrical wiring circuits and understand Circuits.

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SYLLABUS

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16MA3103	FOURIER ANALYSIS AND STATISTICS (COMMON TO AERO, AUTO, MECH, EEE AND E&I)	3	1	0	4

Course Objective

1. Introduce Fourier series analysis which is central to many applications in engineering.
2. Solve boundary value problems by applying Fourier series.
3. Acquaint with Fourier transform techniques used in wide variety of situations.
4. Provide the necessary basic concepts of some statistical methods.
5. Manipulate different kinds of problems occurring in engineering and technology by applying the design of experiments

Unit	Description	Instructional Hours
I	**FOURIER SERIES** Dirichlet's conditions- General Fourier Series – Odd and Even Functions – Half range sine and cosine series – Change of Interval - Parseval's Identity - Harmonic analysis. A spring -mass system deriven by an alterating square force, A series circuit with a sqaure –wave voltage, power delievered by a periodic current and modelling radiation intensity..	12
II	**BOUNDARY VALUE PROBLEMS** Classification – solution of one dimensional wave equation – one dimensional heat equation – steady state solutions of two dimensional heat equations (excluding insulated edges) - Fourier series solution in Cartesian coordinates.	12
III	**FOURIER TRANSFORMS** Fourier Transform Pairs - Fourier sine and cosine transforms – Properties - Transforms of Simple functions – Convolution Theorem – Parseval's identity.	12
IV	**TESTING OF HYPOTHESIS** Large sample test based on Normal distribution for single mean and difference of means - Tests based on t (for single mean and difference of means) - F distribution – for testing difference of variance, Chi – Square test for Contingency table (Test for Independency) – Goodness of fit	12
V	**DESIGN OF EXPERIMENTS** One way and two way classifications - Completely randomized design – Randomized block design – Latin square design.	12
	Total Instructional Hours	**60**

Course Outcome

CO1: Understand the mathematical principles of Fourier series which would provide them the ability to formulate and solve some of the physical problems of engineering.
CO2: Acquire the knowledge of application of Fourier series in solving the heat and wave equations.
CO3: Obtain the knowledge of Fourier transform techniques which extend its applications in Electrical circuit analysis, control system design and signal processing.
CO4: Acquire skills in analyzing statistical methods.
CO5: Have a clear perception of the statistical ideas and demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.

TEXT BOOKS:

T1 - Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., Second reprint, New Delhi, 2012.
T2 - Gupta, S.C., & Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Reprint 2011.

REFERENCE BOOKS:

R1 – C.Roy Wylie " Advance Engineering Mathematics" Louis C. Barret, 6th Edition, Mc Graw Hill Education India Private Limited, New Delhi 2003..
R2 - Kandasamy P., Thilagavathy K. and Gunavathy K.."Engineering Mathematics Volume III", S.Chand & Company Ltd., New Delhi, 1996.
R3- Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition,Pearson Education,Asia,2007.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE3201	AERO ENGINEERING THERMODYNAMICS	3	0	0	3

Course Objective

6. To provide in-depth study of thermodynamic principles, thermodynamics of state.
7. To teach the basic thermodynamic relations for various equipment's and their flow energy
8. To teach students about properties of pure substances and to analyze the performance of thermodynamic air and vapour power cycles.
9. To teach performance calculation of refrigeration systems.
10. To enlighten the basic concepts of propulsion cycles.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO BASIC CONCEPTS AND FIRST LAW** Concept of continuum, macroscopic approach, thermodynamic systems - closed, open and isolated. Property, State, Path and Process, Quasi-static Process, Work, modes of work, Zeroth law of thermodynamics - concept of temperature and heat, internal energy, specific heat capacities, enthalpy - concept of ideal and real gases. First law of thermodynamics - applications to closed and open systems - steady flow processes with reference to various thermal equipment's.	9
II	**SECOND LAW AND ENTROPY** Second law of thermodynamics - Kelvin Planck and Clausius statements of second law. Reversibility and Irreversibility - Carnot theorem, Carnot cycle efficiency - thermodynamic temperature scale - Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy.	8
III	**POWER CYCLES** Otto, Diesel, Dual and Brayton cycles - air standard efficiency - mean effective pressure, Properties of pure substances - thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-V, T -S, H-S diagrams, PVT surfaces, thermodynamic properties of steam - calculations of work done and heat transfer in non-flow and flow processes - standard Rankine cycle	10
IV	**REFRIGERATION AND AIR CONDITIONING** Reversed Carnot cycle - COP - principles of refrigeration, air conditioning - heat pumps - vapour compression - vapour absorption types - coefficient of performance, properties of refrigerants.	9
V	**BASICS OF PROPULSION** Classification of jet engines - simple jet propulsion system - thrust equation - specific impulse - ideal and non-ideal cycle analysis - Introduction to rocket propulsion.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Demonstrate an understanding of the concepts such as conservation of mass, conservation of energy, work interaction, heat transfer and first law of thermodynamics.
CO2: Apply the concept of second law to design simple systems and critically analyse the problem of energy flow in various systems.
CO3: Analyze the performance of gas and vapor power cycles and identify methods to improve thermodynamic performance.
CO4: Able to perform the thermodynamic performance analysis in varied refrigeration conditions.
CO5: Apply the thermodynamic principles and laws on the propulsion systems.

TEXT BOOKS:

BOOKS:

T1 - Nag.P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 2007.
T2 - Rathakrishnan E., "Fundamentals of Engineering Thermodynamics", Prentice-Hall India, 2005.

REFERENCE BOOKS:

R1 - Ramalingam K.K. "Thermodynamics", Sci-Tech Publications, 2006
R2 - Yunus A.Cengal. "Thermodynamics an Engineering Approach", Tata McGraw-Hill Co. Ltd., 3rd Edition, 2002.
R3 - Arora C.P. "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE3202	SOLID MECHANICS	3	0	0	3

Course Objective

1. To introduce various behaviors of materials and analyze the structural components under axial loading conditions.
2. To Sketch the Shear Force and bending moment diagram for beams with various loadings.
3. To calculate the deflections of the beams under various loading conditions.
4. To Predict the Buckling Loads of the columns and to analyze the springs.
5. To give brief descriptions on the behavior of materials due to axial, bending and torsional and combined loads.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Definition of stress, strain and their relations – relations between material constants – axial loading - statically determinate and indeterminate problems in tension & compression.	9
II	**STRESSES IN BEAMS** Shear force & bending moment diagrams: bending and shear stress variation in beams of symmetric sections, beams of uniform strength	9
III	**DEFLECTION OF BEAMS** Double integration method – Macaulay's method – moment area method – conjugate beam method – Maxwell's reciprocal theorem - principle of super position	10
IV	**TORSION – SPRINGS – COLUMNS** Torsion of solid and hollow circular shafts – shear stress variation – open and closed-coiled helical springs – stresses in helical springs - classification of columns – Euler buckling – columns with different end conditions.	10
V	**BIAXIAL STRESSES** Stresses in thin-walled pressure vessels – combined loading of circular shaft with bending, torsion and axial loadings – Mohr's circle and its construction – determination of principal stresses.	7
	Total Instructional Hours	**45**

Course Outcome

CO1: Ability to learn the behaviors of materials under axial loading conditions.
CO2: To draw the Shear Force and bending moment diagram for beams with various loadings.
CO3: To analyze the deflections of the beams under various loading conditions.
CO4: Evaluate the springs and to calculate the Buckling Loads of the columns.
CO5: Ability to draw Mohr's circle for materials due to axial, bending and torsional and combined loads.

TEXT BOOKS:

T1 - William Nash, "Strength of Materials", Tata McGraw Hill, 4th edition, 2010.
T2 - Timoshenko.S. and Young, D.H., 'Elements of Strength of Materials', T.Van Nostrand Co. Inc., Princeton, N.J., 1990.

REFERENCE BOOKS:

R1 - Dym.C.L., and Shames.I.H., 'Solid Mechanics', McGraw Hill, Kogakusha, Tokyo, 1973.
R2 - Stephen Timoshenko, 'Strength of Materials', Vol I & II, CBS Publishers and Distributors, Third Edition, 2016.
R3-R C Hibbeler, "Mechanics of materials", Pearson Education Inc Sixth Edition, 2005.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE3203	ENGINEERING FLUID MECHANICS	3	0	0	3

Course Objective

1. To be familiar with the fluid properties and flow characteristics
2. To understand the importance of conservation laws to flow through circular conduits.
3. To comprehend the importance of dimensional analysis
4. To examine the performance of Pumps
5. To examine the performance of Turbines

Unit	Description	Instructional Hours
I	**PROPERTIES OF FLUID AND FLOW CHARACTERISTICS** Units and dimensions - Properties of fluids - Continuum, density, viscosity, surface tension, compressibility and bulk modulus, concept of pressure. Flow characteristics - concept of control volume - application of continuity equation, momentum and energy equation.	8
II	**FLOW THROUGH CIRCULAR CONDUITS** Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli - Boundary layer concepts - types of boundary layer thickness - Darcy Weisbach equation - friction factor - Moody diagram - commercial pipes - minor losses - Flow through pipes in series and parallel..	8
III	**DIMENSIONAL ANALYSIS** Need for dimensional analysis - methods of dimensional analysis - Similitude - types of similitude - Dimensionless parameters - application of dimensionless parameters - Model analysis.	9
IV	**HYDRAULIC PUMPS** Impact of jets - Euler's equation - Theory of roto-dynamic machines - various efficiencies - velocity components at entry and exit of the rotor - velocity triangles - Centrifugal pumps - working principle - work done by the impeller - performance curves - Reciprocating pump - working principle - Rotary pumps - classification.	10
V	**HYDRAULIC TURBINES** Classification of turbines - heads and efficiencies - velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbine - working principles - work done by water on the runner - draft tube. Specific speed - unit quantities - performance curves for turbines - governing of turbines.	10
	Total Instructional Hours	**45**

Course Outcome

CO1: Ability to apply mathematical knowledge to predict the properties and characteristics of a fluid.
CO2: Capacity in working with the conservative laws and flow through circular conduits
CO3: Proficiency in Dimensional Analysis
CO4: Capability to analyze the performance of pumps
CO5: Aptitude to evaluate the performance of turbines

TEXT BOOKS:

T1 - R. K. Bansal, "Fluid Mechanics and Hydraulics Machines", 5th Edition, Laxmi Publications Ltd., New Delhi, 2005.
T2 - Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2004.

REFERENCE BOOKS:

R1 - Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, "Fluid Mechanics and Machinery", 2011.
R2 - Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2004
R3 - Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE3204	ELEMENTS OF AERONAUTICS	3	0	0	3

Course Objective

1. To introduce the concepts of flying and history of aeronautics and to identify the different components of an aircraft
2. To understand the structure of atmosphere and concept of flight mechanics
3. To know about the various systems and instruments used in aircraft
4. To identify and learn about the basic principles of power plants used in airplanes.
5. To comprehend the various material used in aircraft.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Introduction - Balloon flight – ornithopters - biplanes and monoplanes, Early Airplanes- Pre Wright Brothers era. Wright Flyer, developments in aerodynamics, materials, structures and propulsion over the years. Components of an Airplane and their functions. Components of a rotorcraft and their functions.	9
II	**BASICS OF FLIGHT MECHANICS** Physical properties and structure of the atmosphere, temperature, pressure and altitude relationships, Newton's law of motions applied to aeronautics, Evolution of Lift, Drag and Moment., typical wing plan forms, aerodynamic characteristics of Airfoils, concept of boundary layer, Mach Number, Maneuvers.	9
III	**AIRCRAFT CONFIGURATIONS** Different Types of Flight Vehicles, Classifications, Introduction to stability and control- purpose of controls - Conventional Control, Powered Controls, Typical Systems for control Actuation, basic Instruments for flying, Introduction to Rotorcraft, UAV and MAVs.	9
IV	**AIRCRAFT PROPULSION** Basic Ideas about Air breathing and non-air breathing propulsion – working principle of Piston engine, gas turbine engines and RAM Jet and SCRAM jet Engines - Use of Propeller and Jets for Thrust Production. Comparative Merits - Principles of Operation of Rocket - Types of Rocket and typical applications.	10
V	**AIRCRAFT STRUCTURES AND MATERIALS, AIRWORTHINESS** General Types of Construction, Monocoque, Semi monocoque and Geodesic Construction, Typical Wing and Fuselage Structure. Different materials from wood to super alloys for airplane and engine applications. Materials for space vehicles, FRP materials. Airplane design, type certification and airworthiness certificate.	8
	Total Instructional Hours	**45**

Course Outcome

CO1: Able to Identify the component of Flight and familiarize withy the history of aviation
CO2: To perform basic performance calculation of flight mechanics
CO3: Ability to choose the suitable systems and to measure various flying conditions in aircraft
CO4: Apply the thermodynamic principles to study the performances of different power plants used in aircraft
CO5:Ability to identify the suitable materials for different parts of aircraft

TEXT BOOKS:

T1 - Anderson, J.D., "Introduction to flight", 5th edition, McGraw Hill, 2005
T2 - A.C. Kermode, "Flight without formulae", Pearson education, 5th edition, 2010.

REFERENCE BOOKS:

R1 - Kroes et Aircraft Maintenance and Repair al, 7th edition, McGraw Hill, 2013.
R2 - George P. Sutton and Oscar Biblarz, Rocket Propulsion Elements, 7th edition, John Wiley& Sons, Inc., New York, 2001.
R3 - Houghton, E.L., and Caruthers, N.B., "Aerodynamics for Engineering students", 5th edition, Butterworth-Heinemann Publishers, London, 2003.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE3205	AIRCRAFT SYSTEMS AND INSTRUMENTS	3	0	0	3

Course Objective

1. To impart knowledge of the hydraulic and pneumatic systems components
2. To impart knowledge on operation of airplane control system
3. To know the various systems in an aircraft Engine
4. To enumerate the air-conditioning system in an airplane
5. To identify the types of instruments and its operation including navigational instruments to the students

Unit	Description	Instructional Hours
I	**CONVENTIONAL AIRCRAFT SYSTEMS** Hydraulic systems – components – hydraulic systems controllers – modes of operation – pneumatic systems – working principles – brake system – components, landing gear systems – classification – shock absorbers – retractive mechanism.	8
II	**AIRPLANE CONTROL SYSTEMS** Conventional Systems – power assisted and fully powered flight controls – power actuated systems – engine control systems -Full Authority Digital Engine Control (FADEC) system.– modern control systems – digital fly by wire systems – auto pilot system-Advanced flight control systems.	11
III	**ENGINE SYSTEMS** Fuel systems – piston and jet engines – components - multi-engine fuel systems, lubricating systems - piston and jet engines – engine starting system-Main and After burner fuel control systems.	8
IV	**AIRCONDITIONING AND PRESSURIZING SYSTEM** Basic evaporative air cycle systems – evaporative vapour cycle systems, boot-strap air cycle system – oxygen systems – fire protection systems, deicing and anti icing system.	8
V	**AIRCRAFT INSTRUMENTS** Flight instruments, Navigation and Communication instruments, Gyroscope, Accelerometers, Airspeed indicator, Mach meter, Electronic horizontal situation indicator, Horizontal situation indicator, Multi-Function Display, Attitude director indicator, Primary Flight Display, Engine instruments and display – Operation and principles, Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR).	10
	Total Instructional Hours	**45**

Course Outcome

CO1: Understand the components of airplane systems.
CO2: Knowledge on operation of airplane control system.
CO3: Identify the various systems in an aircraft Engine.
CO4: Understand the operation of air conditioning and pressing system.
CO5: Know the operation of air data instruments system.

TEXT BOOKS:

T1 - Mekinley, J.L. and R.D. Bent, "Aircraft Power Plants", McGraw Hill 1993.
T2 - Pallet, E.H.J, "Aircraft Instruments & Principles", Pitman & Co 1993.

REFERENCE BOOKS :

R1 - Treager, S., "Gas Turbine Technology", McGraw Hill 1997.
R2 - Mckinley, J.L. and Bent R.D. "Aircraft Maintenance & Repair", McGraw Hill,1993.
R3 - Handbooks of Airframe and Power plant Mechanics, US dept. of Transportation, Federal, Aviation Administration, The English Book Store, New Delhi, 1995.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE3001	FLUID MECHANICS AND THERMODYNAMICS LAB	0	0	4	2

Course Objective

1. Upon Completion of this subject, the students can able to have hands on experience in flow measurements using different devices and also perform calculation related to losses in pipes and also perform characteristic study of pumps and turbines
2. To enhance the basic knowledge in basic thermodynamics, heat transfer and Refrigeration systems
3. To provide the basic knowledge about the refrigeration systems

Expt. No.	Description of the Experiments
1.	Determination of the Coefficient of discharge of given Orifice/Venturi meter.
2.	Calculation of the rate of flow using Water/Rota meter.
3.	Determination of friction factor for a given set of pipes.
4.	Conducting experiments and drawing the characteristic curves for the given pump
5.	Conducting experiments and drawing the characteristic curves for the given turbine.
6.	Valve timing of a 4 – stroke engine and port timing of a 2 stroke engine
7.	Determination of thermal conductivity of solid.
8.	Determination of thermal resistance of a composite wall
9.	COP test on a vapour compression refrigeration test rig
10.	COP test on a vapour compression air-conditioning test rig

Total Practical Hours 45

Course Outcome

CO1: Ability to use the measurement equipment for flow measurement
CO2: Carryout Performance trust on different fluid machinery
CO3: Exposure to the characteristics of Pumps and Turbines
CO4: Ability to perform tests on petrol/ diesel engines.
CO5: Able to do performance test in the Refrigeration systems

List of Equipment (for a batch of 30 students)

Sl.No.	Name of the Equipment	Qty.
1	Orifice/Venturi meter.	1
2	Water/Rota meter.	1
3	Pipe Flow analysis setup	1
4	Centrifugal/ Submergible/ Reciprocating/ Gear pump	1
5	Pelton wheel/ Francis/ Kaplan turbine setup	1
6	Cut section model of 4 stroke diesel engine and cut section model of 2 stroke petrol engine	1
7	Conductive heat transfer set up	1
8	Composite wall	1
9	Vapour compression refrigeration test rig	1
10	Vapour compression air-conditioning test rig	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE3002	AIRCRAFT COMPONENT DRAWING LABORATORY	0	0	4	2

Course Objective

1. To design and draft the different aircraft components.
2. To design and draft the different control components.
3. To draw the three different views of a typical aircraft.

Expt. No.	Description of the Experiments
1.	Layout of simple structural components.
2.	Layout of typical wing structure.
3.	Layout of typical fuselage structure.
4.	Layout of landing gear structure
5.	Layout of aircraft control system.
6.	Modelling and drafting control components of cam.
7.	Modelling and drafting control components of bell crank.
8.	Modelling and drafting control components of gear.
9.	Modelling and drafting control components of push pull rod.
10.	Drafting three views of a typical aircraft.

Total Practical Hours 45

Course Outcome

CO1: To draft the design of control components in the aircraft.
CO2: To draft the primary structures of aircraft.
CO3: To design and draft various aircraft components in control system.
CO4: To draft the complete structure of aircraft in three different views.
CO5: To understand the working of all the control components.

List of Equipment (for a batch of 30 students)

Sl.No.	Name of the Equipment	Quantity
1	Computer Nodes	30
2	Modeling Software	30 licenses
3	UPS	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16MA4107	NUMERICAL METHODS	3	1	0	4

(COMMON TO AERO, AUTO, MECH, EEE &EIE)

Course Objective

1. Solve algebraic, transcendental and system of linear equations by using various techniques.
2. Apply various methods to find the intermediate values for the given data.
3. Be familiar with the concepts of numerical differentiation and integration of the unknown functions.
4. Understand the concept of solving Ordinary Differential Equations by applying single and multi step methods.
5. Appraise the methods introduced in the solution of ordinary differential equations and partial differential equations.

Unit	Description	Instructional Hours
I	**SOLUTION OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS** Solution of equation – Fixed point iteration : x = g(x) method – Newton-Raphson method – Solution of linear system by Gauss Elimination and Gauss Jordan method – Iterative method : Gauss seidel method.	12
II	**INTERPOLATION** Interpolation: Newton's forward and backward difference formulae – Lagrangian interpolation for unequal intervals – Divided difference for unequal intervals : Newton's divided difference formula.	12
III	**NUMERICAL DIFFERENTIATION AND INTEGRATION** Differentiation using interpolation formula – Newton's forward and backward interpolation formulae for equal intervals – Newton's divided difference formula for unequal intervals - Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Double integration using Trapezoidal and Simpson's rules	12
IV	**INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS** Single step methods: Taylor's series method – Euler and Modified Euler methods for first order equation – Fourth order Runge- kutta method for solving first order equations – Multi step method: Milne's predictor and corrector method and Adam – Bash forth predictor corrector method.	12
V	**BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS** Finite difference solution of second order ordinary differential equation – Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional Wave equation – Two dimensional Heat equations – Laplace and Poisson Equations.	12
	Total Instructional Hours	**60**

Course Outcome

CO1: Solve the system of linear algebraic equations representing steady state models and non linear equations arising in the field of engineering.
CO2: Understand the concept of interpolation in both cases of equal and unequal intervals.
CO3: Express the information from discrete data set through numerical differentiation and summary information through numerical integration.
CO4: Classify and solve ordinary differential equations by using single and multi step methods.
CO5: Acquire knowledge of finding the solution of ordinary and partial differential equations which are useful in attempting any engineering problem.

TEXT BOOKS:

T1 - Sankara Rao K. "Numerical Methods for Scientists and Engineers", 3rd edition, Prentice Hall of India Private limited, New Delhi.2007..

T2 – M.K.Jain, S.R.K.Iyengar, R.K.Jain "Numerical Methods for Scientific and Computation", Fifth Edition., New age International Publishers 2010.

REFERENCE BOOKS:

R1 - Kreyszig.E. "Advanced Engineering Mathematics", Eight Edition, John Wiley and sons (Asia) limited.

R2 - Grewal B.S. and Grewal J.S. " Numerical Methods in Engineering and Science ", 6th Edition , Khanna publishers, New Delhi 2004.

R3 - S.K.Gupta. Numerical Methods for Engineers, New Age Internationalm Pvt.Ltd Publishers.2015.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE4201	AERODYNAMICS - I	3	0	0	3

Course Objective

1. To provide accumulated knowledge of fluid mechanics.
2. To provide the mathematical understanding of basic flows and their combinations.
3. To demonstrate a fundamental understanding of fluid mechanics applicable to flight, and the forces and moments on airfoil and its conformal transformation.
4. To apply the aerodynamic tools to develop the three dimensional wing and study aerodynamic behavior.
5. To understand the behavior of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.

Unit	Description	Instructional Hours
I	**REVIEW OF BASIC FLUID MECHANICS** Continuity, momentum and energy equations-Differential and Integral forms	6
II	**TWO DIMENSIONAL FLOWS AND GENERATION OF LIFT** Basic flows – Source, Sink, Free and Forced vortex, uniform parallel flow. Their combinations, Pressure and velocity distributions on bodies with and without circulation in ideal and real fluid flows Kutta Joukowski's theorem, Kutta condition.	12
III	**CONFORMAL TRANSFORMATION AND AIRFOIL THEORY** Cauchy-Riemann relations, complex potential, methodology of conformal transformation, Kutta-Joukowski transformation and its applications. Thin airfoil theory and its applications.	11
IV	**SUBSONIC WING THEORY** Vortex filament, Biot and Savart law, bound vortex and trailing vortex, horse shoe vortex, lifting line theory and its limitations.	8
V	**INTRODUCTION TO BOUNDARY LAYER** Newton's law of viscosity, Boundary Layer, Navier-Stokes equation, displacement, Momentum thickness, Flow over a flat plate, Blasius solution.	8
	Total Instructional Hours	**45**

Course Outcome

CO1: To apply governing equation to various fluid flow models
CO2: Able to apply the knowledge of basic flows to the various bodies in the atmosphere for the generation of lift.
CO3: Able to solve the aerodynamic problems associated with the airfoils and the transformation.
CO4: Able to simulate wings with help of aerodynamic tools for various ambient conditions
CO5: Knowledge on incompressible flow and viscous flow.

TEXT BOOKS:

T1 - Houghton, E.L., and Caruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1982.
T2 - Anderson, J.D., "Fundamentals of Aerodynamics", McGraw Hill Book Co., 6th edition, 2016.

REFERENCE BOOKS:

R1 - John J Bertin., "Aerodynamics for Engineers", Pearson Education Inc, 2002
R2 - Clancey, L J.," Aerodynamics", Pitman, 1986
R3 - Milne Thomson, L.H., "Theoretical aerodynamics", Macmillan, 2007.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE4202	MECHANICS OF MACHINES (COMMON TO AERO, AUTO)	3	1	0	4

Course Objective

1. To know different types of inversions in the mechanisms.
2. Study about the working principle gear and gear applications.
3. To know the frictional forces acting and how to resolve the friction.
4. Students should analyze the forces acting on various members in a mechanism.
5. To know the importance of balancing and vibration acting on systems.

Unit	Description	Instructional Hours
I	**KINEMATIC OF MECHANICS** Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.	13
II	**GEARS AND GEAR TRAINS** Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – Epicyclic gear trains – automotive transmission gear trains.	12
III	**FRICTION** Sliding and Rolling Friction angle – friction in threads – Friction Drives – Friction clutches – Belt and rope drives – brakes – Tractive resistance.	11
IV	**FORCE ANALYSIS** Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members. Dynamic Force Analysis – Inertia Forces and Inertia Torque – Alembert's principle – Superposition principle – Dynamic Force Analysis in simple machine members.	12
V	**BALANCING AND VIBRATION** Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines. Free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration isolation.	12
	Total Instructional Hours	**60**

Course Outcome

CO1. Upon completion of this course, the students can design various mechanical components.
CO2. Students have the knowledge on gears and gear trains.
CO3. Students are able to utilize the frictional force into effect.
CO4. Students can analyze the forces acting on the mechanism.
CO5. Students are having the ability to balance the forces and vibration in a machine.

TEXT BOOKS:

T1 - Ambekar A.G., "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007.
T2 - Shigley J.E., Pennock G.R and Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press, 2003.

REFERENCE BOOKS:

R1 - Ghosh.A. and A.K.Mallick, "Theory and Machine", Affiliated East-West Pvt. Ltd., New Delhi, 1988.
R2 - Ramamurthi. V. "Mechanisms of Machine", Narosa Publishing House, 2002.
R3 - Robert L. Norton, "Design of Machinery", McGraw-Hill, 2004.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE4203	GAS TURBINE PROPULSION	3	0	0	3

Course Objective

1. To know the fundamentals of gas turbines and its components
2. To learn about the design and performance of inlets
3. To familiarize with the design and performance characteristics of combustion chamber
4. To understand the design and performance of various aircraft nozzles
5. To teach about the blade design and performance characteristics of different types of compressors

Unit	Description	Instructional Hours
I	**FUNDAMENTALS OF GAS TURBINE ENGINES** Illustration of working of gas turbine engine - Thrust equation - Factors affecting thrust. Effect of pressure, velocity and temperature changes of air entering compressor. Methods of thrust augmentation. Characteristics of turboprop, turbofan, turbojet and turbo shaft engines - Performance characteristics- Numerical Problems.	9
II	**SUBSONIC AND SUPERSONIC INLETS FOR JET ENGINES** Internal flow and Stall in subsonic inlets - Boundary layer separation - Major features of external flow near a subsonic inlet - Relation between minimum area ratio and external deceleration ratio - Diffuser performance - Supersonic inlets - Starting problem on supersonic inlets - Shock swallowing by area variation - External declaration - Modes of inlet operation.	9
III	**COMBUSTION CHAMBERS FOR JET ENGINES** Introduction to combustion Chemistry- Classification of Gas turbine combustion chambers - Important factors affecting combustion chamber design - Combustion process - Combustion chamber performance - Effect of operating variables on performance - Flame tube cooling - Flame stabilization - Use of flame holders.	7
IV	**COMPRESSORS FOR JET ENGINES** Principle of operation of centrifugal compressor - Work done and pressure rise - Velocity diagrams - Diffuser vane design considerations - Concept of prewhirl - Rotation stall - Elementary theory of axial flow compressor - Velocity triangles - Degree of reaction - Three dimensional - Air angle distributions for free vortex and constant reaction design - Compressor blade design - Centrifugal and axial compressor performance characteristics.	10
V	**TURBINES FOR JET ENGINES** Principle of operation of axial flow turbines– Limitations of radial flow turbines- Work done and pressure rise – Velocity diagrams – Degree of reaction – Free vortex and constant nozzle angle designs – Performance characteristics of axial flow turbine– Turbine blade cooling methods – Stage efficiency calculations – Basic blade profile design considerations – Matching of compressor and turbine.	10
	Total Instructional Hours	**45**

Course Outcome

CO1: Analyze thermodynamics of an aircraft jet engine and calculate the performance measures, such as thrust and specific fuel consumption in terms of design requirement.
CO2: Apply the knowledge to design suitable inlets for aircraft at different conditions
CO3: Ability to choose suitable combustion chamber for various aircraft.
CO4: Ability to design various nozzles and do performance calculations
CO5: Evaluate the operating characteristics of compressors and turbines in terms of given blade shapes, angles, and direction of rotation.

TEXT BOOKS:

T1 - Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison - Wesley Longman INC, 1999.
T2 - Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Longman,5th edition, 2001.

REFERENCE BOOKS:

R1 - Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
R2 - Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", 2nd edition, Standard Publishers & Distributors, Delhi, 2008.
R3 - Gorden, C. V., "Aerothermodynamics of Gas Turbine & Rocket Propulsion", AIAA Education Series, New York, 1997

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE4204	AIRCRAFT STRENGTH OF MATERIALS	3	1	0	4

Course Objective

1. To know the theoretical and methodological approaches to the static analysis of determinate and indeterminate aircraft structural components.
2. To familiarize with different types of beams subjected to various types of loading and support conditions.
3. To analyze the stability of column and determine critical buckling loads for various end conditions.
4. To know about the different failure criteria for engineering materials.
5. To develop the knowledge of induced stresses on the aircraft structural components.

Unit	Description	Instructional Hours
I	**STATICALLY DETERMINATE & INDETERMINATE STRUCTURES** Plane truss analysis – method of joints – method of sections – Clapeyron's 3 moment equation and moment distribution method for indeterminate beams.	12
II	**ENERGY METHODS** Strain Energy in axial, bending, torsion and shear loadings. Castigliano's theorems and their applications. Energy theorems – dummy load & unit load methods – energy methods applied to beams & trusses.	13
III	**COLUMNS** Euler's column curve – inelastic buckling – effect of initial curvature – the Southwell plot – columns with eccentricity – theory of beam columns – beam columns with different end conditions – stresses in beam columns.	13
IV	**FAILURE THEORIES** Maximum principal stress theory - maximum principal strain theory - maximum shear stress theory - distortion energy theory – octahedral shear stress theory.	12
V	**INDUCED STRESSES** Thermal stresses – impact loading – Fatigue – Creep - Stress Relaxation - Factors affecting Stress Relaxation and Creep.	10
	Total Instructional Hours	**60**

Course Outcome

CO1: Ability to analysis the forces on beams, trusses under various types of loading and support conditions.
CO2: Ability to calculate deflection and forces for statically determinate and indeterminate aircraft structural components.
CO3: Ability to understand the stability of the column used as aircraft component.
CO4: Ability to design the aircraft structural component using different theories of failure.
CO5: Ability to describe the effects of induced stresses and how this is managed in an aging of aircraft.

TEXT BOOKS:

T1 - Timoshenko and Gere, "Mechanics of Materials", Tata McGraw Hill, 1993.
T2 - Megson T M G, "Aircraft Structures for Engineering students" Elsevier Science and Technology, 2007

REFERENCE BOOKS:

R1 - Donaldson, B.K., "Analysis of Aircraft Structures - An Introduction", McGraw Hill, 1993.
R2 - Peery, D.J. and Azar,J.J., "Aircraft Structures", 2nd Edition, McGraw – Hill, N.Y, 1999.
R3 - Bruhn E F, "Analysis and Design of Flight Vehicle Structures", Tri-State Off-set Company, USA, 1985.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16EI4231	CONTROL ENGINEERING	3	0	0	3

Course Objective

1. State the basic elements of control systems and their transfer function models.
2. Describe the methods of representing and construction of control system components.
3. Discuss time response system analysis.
4. Establish methods of stability analysis and Frequency domain specifications.
5. Outline discrete and sampled data control systems.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO CONTROL SYSTEMS** Historical review of control system – Basic elements in control system – Simple Pneumatic, Hydraulic and Thermal systems – Transfer Function models – Mechanical Translational, Rotational systems – Analogies –mechanical and electrical analogous systems – Development of flight control systems, AFCS.	9
II	**OPEN AND CLOSED LOOP SYSTEMS** Feedback control systems – Control system components – Open and Closed loop system – Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs – Construction– Mason's Gain Formula.	9
III	**TIME RESPONSE ANALYSIS** Laplace transformation – Standard test signals – Order and Type of a system – impulse, step response of first order systems – second order system (under damped and critically damped) –Time domain specifications – Controllers: P,PI,PID – steady state errors and error constants.	9
IV	**STABILITY AND FREQUENCY RESPONSE ANALYSIS** Necessary and sufficient conditions, Routh Array, Routh – Hurwitz criteria – relative stability, Frequency response – advantages – Frequency domain specifications, Types – Root locus and Bode techniques.	9
V	**SAMPLED AND DIGITAL CONTROL SYSTEMS** Z-Transforms, properties – sampled data control systems – sampling process – ZOH and First order Hold – mapping between S and Z planes. Introduction to digital control system, Digital Controllers and Discrete PID controllers – Positional and Velocity Algorithm.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Apply the knowledge for modeling of mechanical and electrical control systems.
CO2: Represent the control system components and reduce them.
CO3: Deduct the different order systems with various inputs and their response.
CO4: Investigate the open and closed loop control systems stability and frequency specifications.
CO5: Analyze sampled and discrete control systems for Aircraft control.

TEXT BOOKS:

T1 - Katsuhiko Ogata, "Modern Control Engineering", Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
T2 - M.Gopal, "Control Systems: Principles and Design", Tata McGraw-Hill Education, 2002.

REFERENCE BOOKS:

R1 - Houpis, C.H. and Lamont, G.B. "Digital Control Systems", McGraw Hill Book Co.,New York,U.S.A.1995.
R2 – A.Nagoor Kani, "Control Systems Engineerig", RBA Publications,Second Edition, 2012.
R3 - Pallet, E.H.J. "Automatic Flight Control", Shroff Publishers, India, 2004.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE4001	AERODYNAMICS LABORATORY	0	0	4	2

Course Objective

1. To study Pressure distribution around different profiles
2. To measure Force around Airfoils
3. To visualize flow over a structure

Expt. No.	Description of the Experiments
1.	Study of subsonic wind tunnel
2.	Calibration of a subsonic Wind tunnel.
3.	Determination of lift for the given airfoil section.
4.	Pressure distribution over a rough circular cylinder.
5.	Pressure distribution over a smooth circular cylinder.
6.	Pressure distribution over symmetric airfoil.
7.	Pressure distribution over cambered airfoil.
8.	Smoke flow visualization studies in subsonic flows.
9.	Water flow visualization studies in subsonic flows using water flow channels
10.	Force measurement on an airfoil using blower balance for small aspect ratio models

Total Practical Hours 45

Course Outcome

CO1: An exposure in the calibration of Wind Tunnel
CO2: Ability to measure force around Airfoils
CO3: Ability to measure force for small Aspect ratio models
CO4: Expertise in study of pressure around different profiles
CO5: Visualize flow using Smoke and water channel

List of Equipment (for a batch of 30 students)

Sl. No.	Name of the Equipment	Quantity
1	Subsonic Wind tunnel	1
2	Models (aerofoil, rough and smooth cylinder, small aspect ratio models)	1 each
3	Blower balance	1
4	Water flow channel	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE4002	AIRCRAFT STRENGTH OF MATERIALS LABORATORY	0	0	4	2

Course Objective

1. To study the properties of materials used in Aircraft structure.
2. To study the failure of different component under different loading condition.
3. Study to improve the hardness of the materials.

Expt. No.	Description of the Experiments
1.	Tension test on mild steel rod.
2.	Double shear test on mild steel and Aluminium rods.
3.	Torsion test on mild steel rod.
4.	Impact test on metal specimen.
5.	Hardness test on metals -Brinell and Rockwell Hardness Number
6.	Compression test on helical spring.
7.	Tempering – Improvement Mechanical properties comparison i) Unhardened specimen ii) Quenched Specimen iii) Quenched and tempered Specimen.
8.	Deflection of a simply-supported beam and cantilever beam.
9.	Verification of superposition theorem
10.	Verification of Maxwell's reciprocal theorem
11.	Construction of south well plot
12.	Truss analysis.
13.	Determination of Elastic constants for a Composite Flexural Specimen.

Total Practical Hours 45

Course Outcome

CO1: Capability to perform various destructive testing.
CO2: Ability to characteristics materials.
CO3: Capability to improve the hardness of the materials.
CO4: Ability to find the deflection of the beams under various loads
CO5: Ability to validate the strength of materials approach with experimental results.

List of Equipment (for a batch of 30 students)

S.No.	Name of the Equipment	Quantity	Experiment No.
1	400 kN Universal Testing Machine	1	1.2.13
2	Torsion testing machine (60 NM capacity)	1	3
3	Impact testing machine (300 J Capacity)	1	4
4	Brinnel Hardness testing machine	1	5
5	Rockwell Hardness testing machine	1	5
6	Spring Testing Machine for tensile and compressive loads (2500 N)	1	6
7	Metallurgical Microscopes	3	5
8	Muffle Furnace	1	7
9	Beams with weight hangers and dial gauges	6	8.9.10
10	Column set up with dial gauges	1	11
11	Truss model	1	12

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SYLLABUS

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5201	AIRCRAFT PERFORMANCE	3	0	0	3

Course Objective

1. To familiarize students with the lift, drag and wing performance.
2. To familiarize students with the cruising flight performance
3. To understand the performance characteristics of climbing and gliding flight.
4. To describe the performance of flight under different maneuvering conditions
5. To familiarize the students with various special performance characteristics of aircraft.

Unit	Description	Instructional Hours
I	**LIFT AND DRAG ON FLIGHT PERFORMANCE** International Standard Atmosphere - Measurement of speed-Forces and moments acting on a flight vehicle -Equation of motion of a rigid flight vehicle - Different types of drag – Methods of drag reduction in airplanes- Drag polar of vehicles from low speed to high speeds - Effects of Reynold's number on skin friction and pressure drag. Variation of thrust, power with velocity and altitudes for air breathing engines.	10
II	**CRUISING FLIGHT PERFORMANCE** Performance of airplane in level flight - Power available and power required curves-Maximum speed in level flight - Conditions for minimum drag and power required.	10
III	**CLIMBING AND GLIDING PERFORMANCE** Climbing Flight- Rate of climb, time to climb - Service and absolute ceiling-Maximum rate of climb and Maximum climb angle -steepest angle of climb-climb hodograph-Gliding flight-minimum rate of sink and shallowest angle of glide- Glide Hodograph	10
IV	**MANEUVERING PERFORMANCE** Turning performance (Turning rate & turn radius)-Bank angle and load factor – limitations on turn - Pull up and push over -V-n diagram, maneuvering envelope.	7
V	**SPECIAL PERFORMANCE** Range and Endurance of jet and propeller type of airplanes, Estimation of take-off and landing distance, High lift devices, Up gust and down gust maneuvering.	8
	Total Instructional Hours	**45**

Course Outcome

CO1: Predict the aerodynamic characteristics of the airplane, the engine performance and how flight altitude affects the airplane performance.
CO2: Calculate the performance of an airplane, mainly for non-accelerating flight states, but also in some simple accelerating cases such as take-off and landing.
CO3: Calculate the aerodynamic and engine data that is needed to perform a performance analysis.
CO4: Design aircraft parameters according to the mission requirement.
CO5: Identify, formulate, and solve engineering problems. This will be accomplished by discussing some open-ended problems in estimating the aircraft performance.

TEXT BOOKS:

T1 - John David Anderson, Jr., 'Aircraft Performance and Design', First Edition, Tata McGraw Hill, 2010.
T2 - Houghton, E. L., and Caruthers, N. B., 'Aerodynamics for Engineering Students', Edward Arnold Publishers, 1988

REFERENCE BOOKS:

R1 - L. J. Clancy, 'Aerodynamics', Pitman, 1986.
R2 - E. L. Houghton, P. W. Carpenter, Steven H Collicott, and Daniel T Valentine, 'Aerodynamic for Engineering Students', Sixth Edition,Butterworth-Heinemann, 2012.
R3 - Barnes W. McCormick, 'Aerodynamics, Aeronautics and Flight Mechanics', Second Edition, John Wiley, New York, 1994.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5202	HIGH SPEED AERODYNAMICS	3	1	0	4

Course Objective

1. To impart knowledge on the basic concepts of compressible flow.
2. To understand about the formation of normal and oblique shocks.
3. To gain knowledge in low speed real flows.
4. To understand the concept of nozzle design.
5. To gain knowledge about the high speed wind tunnels.

Unit	Description	Instructional Hours
I	**FUNDAMENTAL CONCEPTS OF COMPRESSIBLE FLOW** Introduction to isentropic flow-Scope of compressible flow-Review of continuity, momentum and steady flow energy equations and entropy considerations- Energy and momentum equations for compressible fluid flow reference velocities-stagnation states-velocity of sound-critical states-mach number-critical Mach number. Types of waves- mach cones mach angle-effect of Mach number on compressibility flow regimes.	12
II	**SHOCK AND EXPANSION WAVES** Development of normal shocks-governing equations-Stationery and moving normal shock waves-applications. Shock polars, supersonic pitot probes. Oblique shock - Reflection of flow- Prandtl-Meyer expansion flow. Under and over expanded nozzles, shock expansion method for flow over airfoils.	13
III	**FLOW WITH FRICTION AND HEAT TRANSFER** Fanno flow and Rayleigh flow - flow equations and solutions- variation of flow properties-variation of Mach number with duct length-tables and charts for Fanno flow and Rayleigh flow.	11
IV	**TWO DIMENSIONAL COMPRESSIBLE FLOW AND AEROFOIL THEORY** Method of characteristics – Prandtl - Glauert and Goethert rules - Ackeret's supersonic airfoil theory. Small perturbation equations for subsonic, transonic, supersonic and hypersonic flow. Experimental characteristics of Airfoils in compressible flow.	13
V	**EXPERIMENTAL TECHNIQUES FOR HIGH SPEED FLOWS** Blow down, indraft and induction tunnel layouts and their design features. Transonic, supersonic and hypersonic tunnels and their peculiarities. Helium and gun tunnels. Shock tubes. Optical methods of flow visualization.	11
	Total Instructional Hours	**60**

Course Outcome

CO1: Understanding characteristics of compressible fluid flows.
CO2: Capable of identification of shock patterns at different scenario.
CO3: Manipulating the effect caused by real flows.
CO4: Ability to design shock free nozzle.
CO5: Capable of handling wind tunnels for evaluating flow behaviors.

TEXT BOOKS:

T1 - Radhakrishnan, Ethirajan., Gas Dynamics, John Wiley & Sons,2010
T2 - Yahya, S. M., Fundamentals of Compressible flow with Aircraft and Rocket Propulsion, 3rd edition, New Age International Ltd. Publishers, 2003

REFERENCE BOOKS:

R1 - Shapiro, Ascher, H., The Dynamics and Thermodynamics of Compressible Fluid Flow (Vol I & II), Ronald Press, 1954.
R2 - Anderson J. D., Jr., Modern Compressible Flow with Historical Perspective, McGraw Hill Publishing Co., 2004
R3 - Anderson J. D., Jr., Fundamentals to Aerodynamics, McGraw Hill Publishing Co., 3rd edition, 2001

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5203	AIRCRAFT STRUCTURES	3	1	0	4

Course Objective

1. To Calculate the Bending Stress for Unsymmetrical Bending.
2. To Sketch the Shear Flow Distribution for Open Section shear loads.
3. To Sketch the Shear Flow Distribution for Closed Section due torsional and shear loads.
4. To Predict the Buckling Loads of the Thin Plates.
5. To prepare students for designing structural elements of the wing and fuselage sections with minimum weight.

Unit	Description	Instructional Hours
I	**UNSYMMETRICAL BENDING** Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetrical sections – generalized 'k' method, neutral axis method, principal axis method.	12
II	**SHEAR FLOW IN OPEN SECTIONS** Thin walled beams – concept of shear flow – the shear centre and its determination – shear flow distribution in symmetrical and unsymmetrical thin-walled sections –shear flow variation in idealized sections.	12
III	**SHEAR FLOW IN CLOSED SECTIONS** Bredt - Batho theory – single-cell and multi-cell tubes subject to torsion – shear flow distribution in thin-walled single & multi-cell structures subject to bending – with walls effective and ineffective – shear centre of closed sections.	12
IV	**BUCKLING OF PLATES** Bending of thin plates – rectangular sheets under compression - local buckling stress of thin walled sections – crippling strength estimation – load carrying capacity of sheet stiffener panels – effective width.	11
V	**STRESS ANALYSIS OF WING AND FUSELAGE** Loads on an aircraft – the V-n diagram – shear force and bending moment distribution over the aircraft wing and fuselage – shear flow in thin-webbed beams with parallel and non-parallel flanges – complete tension field beams – semi-tension field beam theory.	13
	Total Instructional Hours	**60**

Course Outcome

CO1: Ability to Analysis the Bending stress for wing and fuselage structural component.
CO2: Ability to analyze the shear flow distribution for open section.
CO3: Ability to analyze the shear flow distribution for closed section subjected to torsion and shear.
CO4: Ability to Construct the Aircraft skin with stiffener and their location.
CO5: Ability to identify design features of aircraft wing and fuselage structures, and to calculate load factors and margins of safety for various loading conditions.

TEXT BOOKS:

T1 - Megson T M G , "Aircraft Structures for Engineering Students", Elsevier Ltd, 2007
T2 - Bruhn. E.H., "Analysis and Design of Flight Vehicles Structures", Tri-state off-set Company, USA, 1985.

REFERENCE BOOKS:

R1- Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw Hill, 1993.
R2 - Howard D Curtis, "Fundamentals of Aircraft Structural Analysis", WCB-McGraw Hill, 1997.
R3- Michael Chun-Yung Niu, "Airframe Structural Design: Practical Design Information and Data on Aircraft Structures", 2nd edition, Adaso/Adastra Engineering Center, 2006.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5205	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICE	3	0	0	3

Course Objective

1. To handle the aircraft ground support equipment.
2. To examine the various sub systems of an aircraft.
3. To enumerate various safety procedures
4. To know various types of inspection procedures
5. To identify the various types of aircraft hardware and fluid line fittings.

Unit	Description	Instructional Hours
I	**AIRCRAFT GROUND HANDLING** Mooring, jacking, leveling and towing operations – Preparation – Equipment – precautions– Engine starting procedures – Piston engine, turboprops and turbojets – Ground power unit.	10
II	**GROUND SERVICING OF VARIOUS SUB SYSTEMS** Air conditioning and pressurization – Oxygen and oil systems and their Maintenance – Engine mount and supercharger check	7
III	**MAINTENANCE OF SAFETY** Shop safety – Environmental cleanliness – Precautions – Preservation and De-preservation procedure	8
IV	**INSPECTION** Process – Purpose – Types – Inspection intervals – Techniques – Checklist – Special inspection – Publications, bulletins, various manuals – FAR Air worthiness directives – Type certificate Data sheets – ATA Specifications	10
V	**AIRCRAFT HARDWARE, MATERIALS, SYSTEM PROCESSES** Hand tools – Precision instruments – Special tools and equipments in an airplane maintenance shop – Identifiation terminology – Specification and correct use of various aircraft hardware (i.e. nuts, bolts, rivets, screws etc) – American and British systems of specifications – Threads, gears, bearings, etc – Drills, tapes and reamers – Identification of all types of fluid line fittings. Materials, metallic and non-metallic Plumbing connectors – Cables – Swaging procedures, tests, Advantages of swaging over splicing.	10
	Total Instructional Hours	**45**

Course Outcome

CO1: Ability to carry out ground servicing of critical aircraft systems.
CO2: Understand various subsystems and the safety precautions in maintenance.
CO3: Identify the various safety procedures.
CO4: Knowledge on various inspection procedures
CO5: Knowledge in specifications standards of aircraft hardware systems.

TEXT BOOKS:

T1 - Kroes Watkins Delp, Aircraft Maintenance and Repair, McGraw Hill, New York, 1993.
T2 - Larry Reithmaier, Lawrence .W. Reithmaier, Standard Aircraft Handbook for Mechanics and Technicians, McGraw Hill Professional, 6th Edition, 1999.

REFERENCE BOOKS:

R1 - A&P Mechanics, Aircraft Hand Book, FAA Himalayan Book House, New Delhi, 1996.
R2 - A&P Mechanics, General Hand Book, FAA Himalayan Bok House, New Delhi, 1996.
R3 - Aviation Maintenance Technician Handbook-Power plant, FAA, Aviation Supplies & Academics, 2012, Vol. 2

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5204	ADVANCED PROPULSION	3	0	0	3

Course Objective

1. To impart knowledge in hypersonic propulsion
2. To know the basics of rocket propulsion
3. To understand the working of solid rockets
4. To analyze the performance of liquid propellant engines
5. To understand various propulsion technologies associated with space launch vehicles, missiles and space probes.

Unit	Description	Instructional Hours
I	**RAMJET AND SCRAMJET PROPULSON** Operating principle of ramjet engine – Various components of ramjet engines and their efficiencies – Combustion in ramjet engine –Modes of operation -Ramjet engine and its performance characteristics – Sample ramjet design calculations – Flame stability problems in ramjet combustors. Introduction to hypersonic air breathing propulsion, need for supersonic combustion for hypersonic propulsion – Scramjet engine and its applications for hypersonic vehicles – Problems associated with supersonic combustion - Various types scramjet combustors – Fuel injection schemes in scramjet combustors	10
II	**INTRODUCTION TO CHEMICAL ROCKET PROPULSION AND NOZZLES** Operating principle of a rocket – Specific impulse of a rocket – Internal ballistics – Types of igniters – Air augmented rockets – Pulse rocket motors - Nozzles - Isentropic flow through nozzles - Convergent nozzles and nozzle choking - Nozzle throat conditions. Effect of back pressure in nozzles- Classification of rocket nozzles	9
III	**SOLID ROCKET PROPULSION** Selection criteria of solid propellants – Estimation of solid propellant adiabatic flame temperature - Propellant grain design considerations – Erosive burning in solid propellant rockets – Combustion instability – Strand burner and T-burner – Applications and advantages of solid propellant rockets.	9
IV	**LIQUID ROCKET PROPULSION** Selection of liquid propellants – Various feed systems and injectors for liquid propellant rockets - Thrust control and cooling in liquid propellant rockets and the associated heat transfer problems – Combustion instability in liquid propellant rockets – Peculiar problems associated with operation of cryogenic engines - Introduction to hybrid rocket propulsion	9
V	**ADVANCED PROPULSION TECHNIQUES** Electric rocket propulsion– Types of electric propulsion techniques - Ion propulsion – Nuclear rocket – Future applications of electric propulsion systems - Solar sail	8
	Total Instructional Hours	**45**

Course Outcome

CO1: Knowledge on hypersonic propulsion
CO2: Ability to classify rocket engines
CO3: Ability to calculate various performance parameters
CO4: Knowledge in rocket propulsion systems
CO5: Application of nuclear propulsion in rocketry

TEXT BOOKS:

T1 - Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 8th Edition, 2010.
T2 - B. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", 2nd edition, Standard Publishers and Distributors, Delhi, 2008.

REFERENCE BOOKS:

R1 - Gorden, C. V., "Aerothermodynamics of Gas Turbine & Rocket Propulsion", AIAA Education Series, New York, 1997
R2 - Philip Hill, and Carl Peterson, "Mechanics and Thermodynamics of Propulsion", 2nd edition, Pearson Education Ltd, 2009.
R3 - K Ramamurthi., " Rocket Propulsion", Macmillan 2010.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5001	AIRCRAFT STRUCTURES LABORATORY	0	0	4	2

Course Objective

1. To enable to understand the behavior of aircraft structural components under different loading conditions.
2. To provide the Principle involved in photo elasticity and its applications in stress analysis.
3. To study about non-destructive testing methods.

Expt. No.	Description of the Experiments
1.	Unsymmetrical Bending of a Cantilever Beam
2.	Constant strength Beam
3.	Combined bending and Torsion of a Hollow Circular Tube
4.	terial Fringe Constant of a Photo elastic Models
5.	Shear Centre of an open Channel Section
6.	Shear Centre of a Closed Section
7.	Vibration of a Cantilever Beam
8.	Fabrication of a Composite Laminate.
9.	Tension field beam.
10.	Study of non-destructive testing procedures
11.	Shear failure of bolted and riveted Joints
12.	Influence line study on beams

Total Practical Hours 45

Course Outcome

CO1: To perform Bending and Torsion test on beams.
CO2: Capability to locate the Shear center for the various cross section.
CO5: Ability to conduct Vibration test on beams.
CO4: Capability to fabricate composite specimen
CO5: Ability to perform non-destructive testing to predict the properties of metabolic materials used in aircraft application.

List of Equipment (for a batch of 30 students)

S.No.	Name of the Equipment	Quantity	Experiment No.
1	400 kN Universal Testing Machine	1	10
2	Photo elasticity set up	1	4
3	Vibration set up with accessories	1	7
4	Wagner beam	1	9
5	Unsymmetrical bending set up	1	1
6	Set up for combined bending and torsion	1	3
7	Constant strength beam	1	2
8	Beams with weight hangers and dial gauges	1	12

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5002	PROPULSION LABORATORY	0	0	4	2

Course Objective

1. To familiarize students and to expose them practically to various aircraft piston and gas turbine engines
2. To practically determine the flow behavior of jets
3. To impart the knowledge of characteristics of fuel

Expt. No.	Description of the Experiments
1.	dy of aircraft piston engines
2.	Study of aircraft gas turbine engines
3.	Velocity profiles of free jets.
4.	Velocity profiles of wall jets.
5.	Study of Subsonic Ramjet engine
6.	Cascade testing of compressor and turbine blades
7.	Performance test on a 4-stroke engine
8.	Determination of effectiveness of a parallel flow heat exchanger
9.	Determination of effectiveness of a counter flow heat exchanger
10.	Determination of heating value of a fuel

Total Practical Hours 45

Course Outcome

CO1: Understand details of piston and gas turbine engine
CO2: Perform various testing on ducts, propellants, jet engine components
CO3: Perform test on diesel/petrol engine
CO4: Explain the characteristics of the diesel/Petrol engine
CO5: Determine the properties of the fuels.

List of Equipment (for a batch of 30 students)

Sl.No.	Name of the Equipment	Quantity	Experiment No.
1.	Aircraft Piston engine	1	1
2.	Aircraft gas turbine engine	1	2
3.	Jet facility with compressor and storage tank	1	3,4
4.	Multitube manometer	2	3,4
5.	Ramjet facility	1	5
6.	Cascade Wind tunnel	1	6
7.	Compressor and turbine blade set	1 each	6
8.	4 stroke twin cylinder diesel engine	1	7
9.	Parallel and counter flow heat exchanger test rig	1	8,9
10.	Bomb Calorimeter	1	10

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6201	AIRCRAFT STABILITY AND CONTROL	3	0	0	3

Course Objective

1. To understand the static and dynamic response and controls.
2. To familiarize with the concept of Stability and control of Aircraft.
3. To familiarize with various Aircraft motions and related stability.
4. To familiarize with the concept of dynamic stability of Aircraft.
5. To analyze the longitudinal, lateral, directional stability modes of an aircraft.(static & dynamic)

Unit	Description	Instructional Hours
I	**GENERAL** Degrees of freedom of a system, Static and dynamic stability, Need for stability in an airplane, purpose of controls, Inherently and marginally stable airplanes.	6
II	**STATIC LONGITUDINAL STABILITY** Stick fixed: Basic equations of equilibrium, Stability criterion, Wing and tail moments, Effect of fuselage and nacelles, Effect of c.g. location, Power effects, Stabilizer setting and c.g. location, Elevator effects, stick fixed neutral point. Stick free: Hinge moment coefficients, Stick free neutral point symmetric maneuvers, stick force gradients and stick force per cg. Aerodynamic balancing of control surfaces.	14
III	**STATIC LATERAL STABILITY** Dihedral effect, coupling between rolling moment and yawing moment, Adverse yaw, Aileron power, Aileron reversal.	8
IV	**SATATIC DIRECTIONAL STABILITY** Weather cocking effect, rudder requirements. One engine inoperative conditions, rudder lock.	7
V	**DYNAMIC STABILITY** Equation of motion, Stability derivatives, Routh's discriminant, solving the stability quadratic, Phugoid motion, factors affecting the period and damping- Dutch roll and spiral instability Auto rotation, spin and spin recovery, Two control airplane.	10
	Total Instructional Hours	**45**

Course Outcome

CO1: Calculate aircraft trim and static stability characteristics.
CO2: Perform preliminary design computations to meet static stability and trim requirements.
CO3: Identify the lateral and longitudinal modes and relate the important physical influences of aircraft properties on these modes.
CO4: Determine the stability of the aircraft from the linearized equations of motion.
CO5: Design the control surfaces according to the stability requirements.

TEXT BOOKS:

T1 -Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son:, Inc, New York, 1988.
T2 - Nelson, R.C., 'Flight Stability and Automatics Control', Second Edition, McGraw Hill, 1997.

REFERENCE BOOKS:

R1 - Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1982.
R2 - L. J. Clancy, 'Aerodynamics', Pitman, 1986.
R3 -Houghton, E. L., and Caruthers, N. B., 'Aerodynamics for Engineering Students', Edward Arnold Publishers, 1988

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6202	FINITE ELEMENT METHODS IN ENGINEERING	3	1	0	4

Course Objective

1. To give exposure to the formulation and the procedure of the finite element method.
2. To provide the mathematical foundations of the finite element formulation for engineering applications and solve the same.
3. To study about the various structural elements and their properties.
4. To enumerate the loads acting on various structural elements.
5. To analyze the field variable problems like heat transfer, fluid problems.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Introduction To Finite Element Method – Basic Concepts And Steps In Fem – Overview Of Approximate Methods For The Solution Of The Mathematical Models: Rayleigh-Ritz Methods, Methods Of Weighted Residuals (Galerkin, Least-Squares & Collocation Methods).	11
II	**DISCRETE ELEMENTS** Bar Elements - Uniform Section, Varying Sections - Mechanical And Thermal Loading – Linear And Quadratic Elements, Elimination And Penalty Approach. Plane Truss Analysis: Formulation Of Truss Element - Stiffness Matrix And Force Vector – Element Stress. Beam Bending-Governing Differential Equation For Beam Bending -Two Node Beam Element - Calculation Of Stresses In Beams.	15
III	**CONTINUUM ELEMENTS** Triangular (CST, LST): Plane Stress And Plane Strain Problems - Shape Function - Strain Displacement Matrix – Stress Strain Relationship Matrix - Force Vector – Nodal Displacements – Element Stress. Axisymmetric Elasticity Problems: Axisymmetric Triangular Element – Stress In Cylinders Subjected To Internal Pressure.	13
IV	**ISOPARAMETRIC ELEMENTS** Isoparametric Elements: Shape Functions For Quadrilateral Elements – Four Node Quadrilateral Elements – Serendipity Elements – Numerical Integration For Quadrilateral And Triangular Element Problems - Matrix Solution Techniques.	11
V	**DYNAMIC AND FIELD VARIABLE PROBLEMS** Longitudinal Vibration Of Bars, Lateral Vibration Of Beams, Steady State Heat Transfer: Element Formulations, Treatment To Boundary Conditions With Application To 1-D Heat Conduction, Heat Transfer Through Thin Fins, Fluid Flow Problems, Potential Flow Problems.	10
	Total Instructional Hours	**60**

Course Outcome

CO1. Can understand different mathematical techniques used in FEM analysis and use them for solving structural and thermal problems.
CO2. Calculate the stresses in one dimensional structures.
CO3. Calculate the stresses in two dimensional and axi-symmetric structures
CO4. Evaluate the stresses in non-uniform higher order structures.
CO5. Solving the field variable problems.

TEXT BOOKS:

T1 - Tirupathi.R. Chandrapatla and Ashok D. Belegundu., "Introduction to Finite Elements in Engineering", Prentice Hall India, Third Edition, 2003.
T2 - Rao.S.S., "Finite Element Method in Engineering", 3rd Ed., Butterworth-Heinemann, 1998.

REFERENCE BOOKS:

R1 - Larry J Segerlind., "Applied Finite Element Analysis", Second Edition, John Wiley and Sons, Inc.1984.
R2 - Daryl L. Logan., "A First Course in the Finite Element Method", Cengage Learning, 2011.
R3 - Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6203	COMPOSITE MATERIALS AND STRUCTURES	3	0	0	3

Course Objective

1. To make the student understand the analysis of composite laminates under different loading conditions.
2. To gain knowledge in failure theories of lamina.
3. To provide the mathematical foundations of laminated plates.
4. To give exposure in various methods of fabrication of composite laminates.
5. To Apply the knowledge in failure of sandwich construction

Unit	Description	Instructional Hours
I	**MICROMECHANICS** Introduction - advantages and application of composite materials – types of reinforcements and matrices - micro mechanics – mechanics of materials approach, elasticity approach- fiber volume ratio – mass fraction – density of composites.	10
II	**MACROMECHANICS** Generalized Hooke's Law - elastic constants for anisotropic, orthotropic and isotropic materials - macro mechanics – stress-strain relations with respect to natural axis, arbitrary axis – determination of in plane strengths of a lamina - experimental characterization of lamina. Failure theories of a lamina.	10
III	**LAMINATED PLATE THEORY** Governing differential equation for a laminate. Stress – strain relations for laminate - Different types of laminates - In plane and flexural constants of a laminate. Hygrothermal stresses and strains in a laminate. Impact resistance and interlaminar stresses. Netting analysis	11
IV	**FABRICATION PROCESS AND REPAIR METHODS** Various open and closed mould processes, manufacture of fibers, importance of repair and different types of repair techniques in composites – autoclave and non-autoclave methods.	7
V	**SANDWICH CONSTRUCTIONS** Basic design concepts of sandwich construction - materials used for sandwich construction - failure modes of sandwich panels - bending stress and shear flow in composite beams.	7
	Total Instructional Hours	**45**

Course Outcome

CO1: Understanding the mechanics of composite materials.
CO2: Identify and analyze the failure modes based on failure theories.
CO3: Calculate the stresses and strains in a laminate.
CO4: Apply knowledge gained in manufacturing and repair of composites.
CO5: Solve the structural problems of sandwich panels.

TEXT BOOKS:

T1 - Dam Ishai.. "Mechanics of Composite Materials."
T2 - Autar K Kaw. „Mechanics of Composite Materials". CRC Press. 1997..

REFERENCE BOOKS:

R1 - Agarwal. B.D.. and Broutman. L.J.. "Analysis and Performance of Fibre Composites." John Wiley and sons. Inc.. New York. 1995.
R2 - Madhuji Mukhapadhyay. Mechanics of Composite Materials and Structures. University Press. 2004.
R3 - Allen Baker. "Composite Materials for Aircraft Structures". AIAA Series. II Edition. 1999.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6001	AIRCRAFT DESIGN PROJECT	0	0	4	2

Course Objective

1. To enable to understand the behavior of aircraft structural components under different loading conditions.
2. To provide the Principle involved in photo elasticity and its applications in stress analysis.
3. To study about non-destructive testing methods.

Expt. No.	Description of the Experiments
1.	Comparative studies of different types of airplanes and their specifications an performance details with reference to the design work under taken.
2.	Comparative graphs preparation and selection of main parameters for the design.
3.	Preliminary weight estimation.
4.	Power plant selection, aerofoil selection, fixing the geometry of Wing, tail, control surfaces
5.	Drag Estimation
6.	Detailed performance calculations and stability estimates.
7.	V-n diagram.
8.	Landing gear selection & design
9.	Preliminary design of an aircraft wing – Shrenck's curve, structural load distribution, shear force, bending moment and torque diagrams
10.	Detailed design of an aircraft wing – design of spars and stringers, bending stress and shear flow calculations
11.	Preliminary design of an aircraft fuselage – load distribution on an aircraft fuselage
12.	tailed design of an aircraft fuselage – design of bulkheads and longerons –bending stress and shear flow calculations.
13.	Preparation of a detailed design report with CAD drawings

Total Practical Hours **45**

Course Outcome

CO1: Ability design aircraft and demonstrate the performance of the design
CO2: Capacity to design g aircraft wings, fuselage, loading gears.
CO3: Ability to angle the design in terms of structural point of view.
CO4: Apply the knowledge of aircraft structure to choose suitable materials to different components of aircraft.
CO5: Ability to visualize and draw three view diagrams of the aircraft.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6002	COMPUTER AIDED SIMULATION LABORATORY	0	0	4	2

Course Objective

1. To make the students familiarize with computational fluid dynamics.
2. To practice on structural analysis software tools.
3. By employing these tools for Aerospace applications students will have an opportunity to expose themselves to simulation software.

Expt. No.	Description of the Experiments
1.	Simulation of flow through a Converging-diverging nozzle
2.	Simulation of flow through an axial flow compressor blade passage
3.	Simulation of supersonic flow over a wing of biconvex cross section
4.	Hot flow simulation through an axial flow turbine blade passage
5.	Simulation of flow through subsonic and supersonic diffusers
6.	Structural analysis of a tapered wing
7.	Structural analysis of a fuselage structure
8.	Analysis of a composite laminate structure
9.	Structural analysis of a landing gear
10.	Thermo structural analysis of a composite laminate structure

Total Practical Hours 45

Course Outcome

CO1. Explore different simulation and analysis software tools.
CO2. Execute design and analysis of various components.
CO3. Simulate flow behavior and perform structural analysis.
CO4. Analyze the problems for the better solution.
CO5. Students can meet the industry requirement excel in structural and flow analysis

List of Equipment (for a batch of 30 students)

Sl. No.	Equipment	Qty.
1	Internal server (or) Work station	1
2	Computers	30
3	Modelling packages (i) CATIA (ii) ANSYS (iii) Pro E (iv) NASTRAN	30 licenses
4	UPS	1
5	Printer	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6003	AIRCRAFT SYSTEMS LABORATORY	0	0	4	2

Course Objective

1. To train the students "ON HAND" experience in maintenance of various air frame systems in aircraft and rectification of common snags.
2. To impart knowledge on various checks of aircraft.
3. To gain knowledge about various trouble shooting methods.

Expt. No.	Description of the Experiments
1.	Aircraft "Jacking Up" procedure
2.	Aircraft "Levelling" procedure
3.	Control System "Rigging check" procedure
4.	Aircraft "Symmetry Check" procedure
5.	"Flow test" to assess of filter element clogging
6.	"Pressure Test" To assess hydraulic External/Internal Leakage
7.	"Functional Test" to adjust operating pressure
8.	"Pressure Test" procedure on fuel system components
9.	"Brake Torque Load Test" on wheel brake units
10.	Maintenance and rectification of snags in hydraulic and fuel systems.

Total Practical Hours 45

Course Outcome

CO1: Ability to carry out basic maintenance activities involved in aircraft.
CO2: Capable of carrying out symmetry checks.
CO3: Ability to conduct various pressure and functional tests.
CO4: Enable to rectify the snags in aircraft hydraulic & pneumatic systems.
CO5: Identification of reasons involved at the time of malfunctioning.

List of Equipment (for a batch of 30 students)

Sl. No.	Item	Quantity	Experiment No.
1	Serviceable aircraft with all above systems	1	1,2,3,4,5,6,7,8,9,10
2	Hydraulic Jacks (Screw Jack)	5	1,2,4,8
3	Trestle adjustable	5	1,2,4,8
4	Spirit Level	2	8
5	Levelling Boards	2	8
6	Cable Tensiometer	1	8
7	Adjustable Spirit Level	1	8
8	Plumb Bob	1	8

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PROFESSIONAL ELECTIVE-I

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5301	AIRCRAFT MATERIALS AND PROCESSES	3	0	0	3

Course Objective

1. To study the various types of materials and its structure
2. To analyze mechanical behavior of materials
3. To understand various types of corrosion in the materials
4. To identify the various types of composite materials and its uses
5. To understand Heat treatment processes of aircraft materials

Unit	Description	Instructional Hours
I	**ELEMENTS OF AEROSPACE MATERIALS** Structure of solid materials – Atomic structure of materials – crystal structure – miller indices – density– packing factor – space lattices – x-ray diffraction – imperfection in crystals – physical metallurgy -general requirements of materials for aerospace applications.	9
II	**MECHANICAL BEHAVIOUR OF MATERIALS** Linear and non linear elastic properties – Yielding, strain hardening, fracture, Bauchinger's effect – Notch effect testing and flaw detection of materials and components – creep - fatigue – fracture mechanics.	9
III	**HEAT TREATMENT AND CORROSION** Types of corrosion – effect of corrosion on mechanical properties – stress corrosion cracking – corrosion resistance materials used for space vehicles heat treatment of carbon steels – aluminium alloys, magnesium alloys and titanium alloys – effect of alloying treatment, heat resistance alloys – Corrosion Resistant materials used in aircraft	10
IV	**CERAMICS AND COMPOSITES** Introduction – powder metallurgy - modern ceramic materials – cermets - cutting tools – glass ceramic –production of semi fabricated forms - plastics and rubber – carbon/carbon composites, fabrication processes involved in metal matrix composites - shape memory alloys – wood and fabric in aircraft construction	9
V	**HIGH TEMPERATURE MATERIALS CHARACTERIZATION** Classification, production and characteristics – methods and testing – determination of mechanical and thermal properties of materials at elevated temperatures – application of these materials in thermal protection systems of aerospace vehicles – Emerging trends in aerospace application	8
	Total Instructional Hours	**45**

Course Outcome

CO1. Knowledge in evolution of materials and its structure.
CO2. Ability to understand various material behaviour.
CO3. Understand the role of corrosion and heat treatment processes of aircraft materials.
CO4. Knowledge in usage of composite materials in aircraft component design.
CO5. Exposure to high temperature materials for space applications.

TEXT BOOKS:

T1 - Titterton.G., "Aircraft Materials and Processes", V Edition, Pitman Publishing Co., 1995.
T2 - Raghavan.V., "Materials Science and Engineering", Prentice Hall of India, New Delhi, 1993

REFERENCE BOOKS:

R1 - Martin, J.W., "Engineering Materials, Their properties and Applications", Wykedham Publications (London) Ltd., 1987.
R2 - Popov., "Engineering Mechanics of Solids", Prentice Hall of India.2003.
R3 - Van Vlack.L.H., "Materials Science for Engineers" Addison Wesley, 1985

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5302	HEAT TRANSFER	3	0	0	3

Course Objective

1. To introduce the concepts of heat transfer to enable the students understand the thermal systems and conduction behavior of various solids.
2. To give mathematical knowledge of convection heat transfer for various ambience.
3. To give analytical knowledge to the Radiation heat transfer.
4. To give exposure to numerical methods employed to solve heat transfer problems.
5. To provide the basic knowledge about heat transfer problems in the Aerospace field.

Unit	Description	Instructional Hours
I	**HEAT CONDUCTION** Basic Modes of Heat Transfer – One dimensional steady state heat conduction, Composite Medium – Critical thickness – Effect of variation of thermal Conductivity –Extended Surfaces – Unsteady state, Heat Conduction: Lumped System Analysis – Heat Transfer in Semi-infinite and infinite solids – Use of Transient – Temperature charts – Application of numerical techniques	11
II	**CONVECTIVE HEAT TRANSFER** Introduction – Free convection in atmosphere free convection on a vertical flat plate –Empirical relation in free convection – Forced convection – Laminar and turbulent convective heat transfer analysis in flows between parallel plates, over a flat plate and in a circular pipe. Empirical relations, application of numerical techniques in problem solving.	10
III	**HEAT EXCHANGERS** Classification – Temperature Distribution – Overall heat transfer coefficient, Heat Exchange Analysis – LMTD Method and E-NTU Method.	8
IV	**RADIATIVE HEAT TRANSFER** Introduction to Physical mechanism – Radiation properties – Radiation shape factors – Heat exchange between non – black bodies – Radiation shields.	8
V	**HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING** High-Speed flow Heat Transfer, Heat Transfer problems in gas turbine combustion chambers – Rocket thrust chambers – Aerodynamic heating – Ablative heat transfer.	8
	Total Instructional Hours	**45**

Course Outcome

CO1: Able to do basic calculations involving conduction heat transfer in various solids.
CO2: Able to perform the convection phenomenon to the varied environment conditions and the equipment's
CO3: Able to understand the radiation heat transfer in the ambient conditions of the various equipment's
CO4: Able to solve the heat transfer problems with help of numerical methods
CO5: Able to predict heat transfer problems in the propulsive device.

TEXT BOOKS:

T1-Yunus A.Cengel.,"Heat Transfer – A practical approach", Second Edition, Tata McGraw-Hill, 2002.
T2-Sachdeva, S.C., "Fundamentals of Engineering Heat & Mass Transfer", Wiley Eastern Ltd., New Delhi, 1981.

REFERENCE BOOKS:

R1- Mathur, M. and Sharma, R.P. "Gas Turbine and Jet and Rocket Propulsion", Standard Publishers, New Delhi 1988.
R2 - Holman,J.P., "Heat Transfer", McGraw Hill Book Co.,Inc., New York, Sixth Edition,1991.
R3 - Lienhard,J.H., A Heat Transfer Text Book, Prentice Hall Inc., 1981.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5303	BOUNDARY LAYER THEORY	3	0	0	3

Course Objective

1. To gain knowledge about the concepts of basic flow equations.
2. To impart knowledge on the growth of boundary layer.
3. To understand the various boundary layer profile.
4. To gain knowledge on the wake formation.
5. To understand about various boundary layer control techniques.

Unit	Description	Instructional Hours
I	**FUNDAMENTAL EQUATIONS OF VISCOUS FLOW** Fundamental equations of viscous flow. Conservation of mass. Conservation of Momentum-Navier-Stokes equations. Energy equation. Mathematical character of basic equations. Dimensional parameters in viscous flow. Non-dimensionalising the basic equations and boundary conditions. vorticity considerations. creeping flow. boundary layer flow	8
II	**SOLUTIONS OF VISCOUS FLOW EQUATIONS** Solutions of viscous flow equations. Couette flows. Hagen-Poisuelle flow. Flow between rotating concentric cylinders. Combined Couette-Poiseuille Flow between parallel plates. Creeping motion. Stokes solution for an immersed sphere. Development of boundary layer. Displacement thickness. momentum and energy thickness.	10
III	**LAMINAR BOUNDARY LAYER** Laminar boundary layer equations. Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – boundary layer over a curved body-Flow separation- similarity solutions. Falkner–Skan wedge flows. Boundary layer temperature profiles for constant plate temperature –Reynold's analogy. Integral equation of Boundary layer – Pohlhausen method – Thermal boundary layer calculations.	10
IV	**TURBULENT BOUNDARY LAYER** Turbulence-physical and mathematical description. Two-dimensional turbulent boundary layer equations — Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient.	10
V	**BOUNDARY LAYER CONTROL** Boundary layer control in laminar flow-Methods of Boundary layer control: Motion of the solid wall- Acceleration of the boundary layer-Suction- Injection of different gas-Prevention of transition-Cooling of the wall-Boundary layer suction-Injection of a different gas.	7
	Total Instructional Hours	**45**

Course Outcome

CO1. Capable of identifying the flow types.
CO2. Manipulating the growth of boundary layer thickness.
CO3. Capable of evaluating the effect of boundary layer.
CO4. Ability to understand the effect of wake in turbulent flow.
CO5. Acquire knowledge on control of boundary layer growth.

TEXT BOOKS:

T1 - White. F. M.. Viscous Fluid Flow. McGraw-Hill & Co.. Inc.. New York 2008.
T2 - NASA Technical reports. Numerical Simulation of Boundary Layers. 1986.

REFERENCE BOOKS:

R1 - Schlicting. H.. Boundary Layer Theory. McGraw-Hill. New York. 1979.
R2 - Reynolds. A. J.. Turbulent Flows Engineering. John Wiley and Sons. 1980.
R3 - Stephen B.Pope.Turbulent flows. Cambridge University Press. 2008.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE5304	PRINCIPLES OF MANAGEMENT (Only for AERO)	3	0	0	3

Course Objective

1. To introduce the basic of management.
2. To impart knowledge about planning
3. To gain more knowledge on organizing and staffing
4. To impart knowledge about directing
5. Students will also gain some basic knowledge on controlling

Unit	Description	Instructional Hours
I	**INTRODUCTION TO MANAGEMENT** Definition of Management - Science or Art - Manager Vs Entrepreneur- Management and Administration - Development of Management Thought - Contribution of Taylor and Fayol – Functions of Management - Types of Business Organisation.	9
II	**PLANNING** Nature & Purpose - Steps involved in Planning - Objectives – Setting Objectives - Process of Managing by Objectives - Strategies, Policies & Planning Premises- Forecasting - Decision-making.	8
III	**ORGANISING AND STAFFING** Nature and Purpose - Types of Organization - Organization Chart - Structure and Process – Departmentalization by difference strategies - Line and Staff authority - Benefits and Limitations - Difference between authority and power- Centralization, De-Centralization and Delegation of Authority - Staffing - Selection Process - Techniques – Human Recourse management.	10
IV	**DIRECTING** Scope - Human Factors - Creativity and Innovation - Leadership - Types of Leadership Motivation - Hierarchy of needs - Motivation theories - Motivational Techniques - Job Enrichment - Communication - Process of Communication - Barriers and Breakdown - Effective Communication - Electronic media in Communication.	9
V	**CONTROLLING** System and process of Controlling - Requirements for effective control - budgetary and non-budgetary control techniques - Information Technology in Controlling - Use of computers in handling the information - Productivity - Problems and Management - Direct and Preventive Control - Reporting - The Global Environment - Globalization and Liberalization.	9
	Total Instructional Hours	**45**

Course Outcome

CO1. Knowledge of management
CO2. Ability to have clear understanding of planning
CO3. Ability to have clear understanding of organizing and staffing
CO4. Ability to have clear understanding of staffing
CO5. Have some basic knowledge on international aspect of management.

TEXT BOOKS:

T1 - Harold Kooritz & Heinz Weihrich "Essentials of Management", Tata McGraw-Hill, 1998
T2 - Tripathy PC & Reddy PN, "Principles of Management", Tata McGraw Hill, 1999.

REFERENCE BOOKS:

R1 - Charles W L Hill, Steven L McShane, 'Principles of Management', Mcgraw Hill.
R2 - Joseph L Massie "Essentials of Management", Prentice Hall of India, (Pearson) Fourth Edition, 2003.
R3 - Stephen P. Robbins & Mary Coulter, "Management", 10th Edition, Prentice Hall (India) Pvt. Ltd., 2009.

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PROFESSIONAL ELECTIVE-II

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6301	THEORY OF ELASTICITY	3	0	0	3

Course Objective

1. Ability to analyze some real problem and to formulate the conditions of theory of elasticity application
2. To make the student understand the elastic behavior of different structural components under various loadings and boundary conditions.
3. Students can able to analyze the result of solution by standard computational programs
4. To execute a reasonable choice of parameters of the model (geometry, material properties, boundary conditions)
5. To understand the theoretical concepts of material behavior with particular emphasis on their elastic property.

Unit	Description	Instructional Hours
I	**BASIC EQUATIONS OF ELASTICITY** Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants.	9
II	**PLANE STRESS AND PLANE STRAIN PROBLEMS** Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two-dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.	9
III	**POLAR COORDINATES** Equations of equilibrium, Strain - displacement relations, Stress – strain relations, Airy's stress function, Axi – symmetric problems, Introduction to Dunder's table, Curved beam analysis, Lame's, Kirsch, Michell's and Boussinesque problems – Rotating discs.	9
IV	**TORSION** Navier's theory, St. Venant's theory, Prandtl's theory on torsion, semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections. Membrane Analogy.	9
V	**INTRODUCTION TO THEORY OF PLATES AND SHELLS** Classical plate theory – Assumptions – Governing equations – Boundary conditions – Navier's method of solution for simply supported rectangular plates – Levy's method of solution for rectangular plates under different boundary conditions.	9
	Total Instructional Hours	**45**

Course Outcome

1: Understand the fundamental equations used for forming the equilibrium equations.
2: Able to find stress in two dimensional structures using Cartesian co-ordinates
3: Able to find stress in polar co-ordinates and axi-symmetric structures.
4: Able to solve stress in cylindrical structures.
5: Introduction to methods used for solving plate and shell structures.

TEXT BOOKS:

T1 - Timoshenko, S., and Goodier, T.N., "Theory of Elasticity", McGraw – Hill Ltd., Tokyo, 1990.
T2 - Bhaskar, K., and Varadan, T. K., "Theory of Isotropic/Orthotropic Elasticity", CRC Press USA, 2009.

REFERENCE BOOKS:

R1 - Volterra & J.H. Caines, "Advanced Strength of Materials", Prentice Hall, New Jersey, 1991
R2 - Sokolnikoff, I. S., "Mathematical Theory of Elasticity", McGraw – Hill, New York, 1978.
R3 - Wang, C. T., "Applied Elasticity", McGraw – Hill, New York, 1993

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6302	INTRODUCTION TO CRYOGENICS	3	0	0	3

Course Objective

1. To impart knowledge on the cryogenic fluids
2. To predict the storage problems of cryogenic fluids
3. To analyze the operating cycles
4. To understand the thermodynamics of cryogenics
5. To enumerate the applications of cryogenics

Unit	Description	Instructional Hours
I	**INTRODUCTION** Historical Background - Introduction to cryogenic propellants - Liquid hydrogen, liquid helium, liquid nitrogen and liquid oxygen and their properties	7
II	**LOW TEMPERATURE PRODUCTION** Theory behind the production of low temperature - Expansion engine heat exchangers - Cascade process Joule Thompson Effect - Magnetic effect - Ortho and H2 - Helium4 and Helium 3	10
III	**EFFICIENCY OF CRYOGENIC SYSTEMS** Types of losses and efficiency of cycles - specific amount of cooling - The fraction liquified – Cooling coefficient of performance - Thermodynamic efficiency – The energy balance Method	10
IV	**OPERATION CYCLES OF CRYOGENIC PLANTS** Classification of cryogenic cycles - The structure of cycles - Throttle expansion cycles - Expander cycles - Thermodynamic analysis - Numerical problems	10
V	**CRYOGENIC IN AEROSPACE APPLICATIONS** Cryogenic liquids in missile launching and space simulation Storage of cryogenic liquids - Effect of cryogenic liquids on properties of aerospace materials – Cryogenic loading problems - Zero gravity problems associated with cryogenic propellants - Phenomenon of tank collapse - Elimination of Geysering effect in missiles	8
	Total Instructional Hours	**45**

Course Outcome

CO1.	Understand the evolution of cryogenic fluids
CO2.	Understand the storage problems of cryogenic fluids
CO3.	Ability to predict the heat transfer characteristics
CO4.	Identification of operating cycles
CO5.	Knowing the application of cryogenics

TEXT BOOKS:

T1 - Haseldom, G., Cryogenic Fundamentals, Academic Press, 1971
T2 - Barron, R. F., Cryogenic Systems, Oxford University, 1985

REFERENCE BOOKS:

R1 - Parner, S. F., Propellant Chemistry, Reinhold Publishing Corpn., New York 1985
R2 - Randall Barron., Cryogenics systems , Mc Graw Hill Book Co
R3 - Valery V. Kostionk., "A Text Book Of Cryogenics", Discovery Publishing House, 2003

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6303	WIND TUNNEL TECHNIQUES	3	0	0	3

Course Objective

1. To interpret the basic concepts of measurement of forces and moments on models during the wind tunnel testing.
2. To understand the application of various types of wind tunnels.
3. To know the calibration techniques used in wind tunnels.
4. To learn the basic measurement procedure involving wind tunnel testing
5. To study the various flow visualization methods in wind tunnels.

Unit	Description	Instructional Hours
I	**PRINCIPLES OF MODEL TESTING** Buckingham Theorem – Non-Dimensional Numbers –Scale Effect Types of Similartes.	6
II	**WIND TUNNELS** Introduction to wind tunnels - Classification – Special problems of Testing in Subsonic, Transonic, supersonic and hypersonic speed regions – Layouts – sizing and design parameters.	8
III	**CALIBRATION OF WIND TUNNELS** Test section speed – Horizontal buoyancy – Flow angularities – Turbulence measurements – Associated instrumentation – Calibration of supersonic tunnels.	11
IV	**WIND TUNNEL MEASUREMENTS** Pressure and velocity measurements – Force measurements – Three component and six component balances – Internal balances	12
V	**FLOW VISUALIZATION** Smoke and Tuft grid techniques – Dye injection special techniques – Optical methods of flow visualization.	8
	Total Instructional Hours	**45**

Course Outcome

CO1: Understand the principles and opretion of windtunnels
CO2: Analyse the different components in wind tunnel
CO3: Calibrate the wind tunnel
CO4: Ability to measure various flow parameters
CO5: Visualize the flow over the component by using various techniques

TEXT BOOKS:

T1 - Rae, W.H. and Pope, A. "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.
T2 - NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998

REFERENCE BOOKS:

R1 - Pope, A., and Goin, L., "High Speed wind Tunnel Testing", John Wiley, 1985.
R2 - Lecture course on "Advanced Flow diagnostic techniques" 17-19 September 2008 NAL, Bangalore.
R3 - Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids." CRC Press – Taylor & Francis, 2007.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6304	AERO ENGINE MAINTENANCE AND REPAIR	3	0	0	3

Course Objective

1. To make the students understand about the piston engine and its operation.
2. To interpret the basic concepts of inspections of piston engines
3. To learn the fundamentals of propeller and its inspection methods.
4. To make the students to familiarize with the Aircraft engine maintenance procedure and practice.
5. To study the basic concepts of the maintenance and repair of both piston and jet aero engines and the procedures followed for overhaul of aero engines.

Unit	Description	Instructional Hours
I	**PISTON ENGINE** Types of piston engines – Principles of operation – Function of components – Materials used – Details of starting the engines – Details of carburetion and injection systems for small and large engines – Ignition system components – Spark plug details – Engine operating conditions at various altitudes – Lubrication system. Maintenance and inspection checks to be carried out.	8
II	**INSPECTIONS OF PISTON ENGINES** Inspection and maintenance and troubleshooting – Inspection of all engine components – Daily and routine checks – Overhaul procedures – Compression testing of cylinders – Special inspection schedules – Engine fuel, control and exhaust systems – Engine mount and super charger – Checks and inspection procedures. Methods and instruments for non-destructive testing techniques – Equipment for replacement of part and their repair	8
III	**PROPELLERS** Propeller theory - operation, construction assembly and installation - Pitch change mechanism- Propeller axially system- Damage and repair criteria - General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions – Damage and repair criteria.	10
IV	**JET ENGINES , TESTING AND INSPECTION** Types of jet engines – Fundamental principles – Bearings and seals - Inlets - compressors- turbines- exhaust section – classification and types of lubrication and fuels- Materials used - Details of control, starting around running and operating procedures – Inspection and Maintenance- permissible limits of damage and repair criteria of engine components- internal inspection of engines- compressor washing- field balancing of compressor fans- Component maintenance procedures - Systems maintenance procedures - use of instruments for online maintenance - Special inspection procedures- Foreign Object Damage - Blade damage . Maintenance procedures of gas turbine engines – Trouble shooting and rectification procedures.	12
V	**OVERHAULING** Engine overhaul – Overhaul procedures- inspection and cleaning of the components – repair schedules for overhaul- balancing of gas turbine components Trouble shooting: procedures for trouble shooting – condition monitoring of the engine on ground and at flight – engine health monitoring and corrective methods.	7
	Total Instructional Hours	**45**

Course Outcome

CO1:Apply maintenance procedure to Aircraft Engines
CO2: Identify the engine components and faults
CO3: Knowing the fundamentals of propellers.
CO4:Apply non-destructive testing procedures to identify the defects
CO5: Apply overhauling procedure to new engines

TEXT BOOKS:

T1 - KROES & WILD, "Aircraft Power plants", 7th Edition – McGraw Hill, New York, 1994.
T2 - Brimm D.J. Bogges H.E., "Aircraft Maintenance", Pitman Publishing corp., New York, 1940.

REFERENCE BOOKS:

R1 - Turbomeca, " Gas Turbine Engines ", The English Book Store ", New Delhi, 1993.
R2 - United Technologies Pratt & Whitney, "The Aircraft Gas turbine Engine and its Operation", The English Book Store, New Delhi.
R3 - Mekinly, J.L. and Bent, R.D., "Aircraft Power Plants", McGraw Hill, 1993.

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OPEN ELECTIVE - I

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE6401	INTRODUCTION TO FLIGHT	3	0	0	3

Course Objective

1. To understand the concept of flying and instruments associated with it.
2. To gain knowledge about the structural design and material of aircraft components.
3. To provide the basic idea about the working principle of aircraft power plants.
4. To understand the concept of space vehicles.
5. To gain knowledge on helicopter flight mechanism.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO AIRPLANES** Introduction, historical background. Different types of flight vehicles. Components of an airplane and their functions. Conventional control. Basic instruments for flying. Physical properties and structure of the atmosphere. (Temperature. Pressure and altitude relationships). Evolution of lift. Drag and moment. Aero foils. Avionics: Flight deck and cockpit.	9
II	**AIRPLANE STRUCTURES AND MATERIALS** Introduction to structural design of Aircraft and spacecraft. flight loads. general types of construction. Monocoque. Semi-monocoque and composite structure construction. Typical wing and fuselage structure. Metallic and Non metallic materials. Use of aluminium alloy. titanium. stainless steel and composite materials in aerospace.	9
III	**AIRCRAFT ENGINES** Selection of power plants: piston. turbo-propeller. turbofan. and jet engines with after burner / thrust augmentation thrust vector control. FADEC. Use of propeller and jets for thrust production. Comparative merits. Theory of Propellers.	9
IV	**SPACE SYSTEM DESIGN** Overview on space environment. introduction to space debris. Launch site selection. Brief introduction to rockets. ramjet. and SCRAMJET. Thrust vector control mechanisms. staging of rockets. space mission. re-entry vehicles. life support systems for manned space missions. Fuel cells. Introduction to space mechanics to satellites. Interplanetary missions. Space exploration.	9
V	**ROTORCRAFT, UAVs, AND AIRCRAFT SYSTEMS** Introduction to Helicopters and Micro-lights. Introduction to UAVs and MAVs. Types and applications. Maintenance. safety and operations. Basic principles and lay out of various aircraft systems: Hydraulic system. Aircraft Fuel system. Engine fuel system. Air conditioning and Pressurization system Flight control system. Navigation and Weapon control system. Under carriage and Brake system. High lift devices.	9
	Total Instructional Hours	**45**

Course Outcome

CO1. Understand about the fundamentals of various flight configurations.
CO2. Capable of choosing the correct material for specified components.
CO3. Understand about the basic science of aircraft engines.
CO4. Ability to understand about the space vehicles behavior.
CO5. Capable of implementing the ideas on helicopter aerodynamics.

TEXT BOOKS:

T1 - Anderson J.D., Introduction to Flight. McGraw-Hill 7th edition. 2013.
T2 - Austin R., Unmanned Aircraft Systems. AIAA Education Series. 2010.

REFERENCE BOOKS:

R1 - Dava Newman. Interactive Aerospace Engineering and Design. McGraw-Hill. 2nd edition., 2002.
R2 - Kermode. A.C., "Mechanics of Flight", Himalayan Book. 1997
R3 - Kermode A.C. " Flight without formulae", Pearson Education., Fifth edition.1989.

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SYLLABUS

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7201	AVIONICS	3	0	0	3

Course Objective

1. To introduce the basic of avionics and its need for civil and military aircrafts
2. To impart knowledge about the avionic architecture, various avionics data buses
3. To gain more knowledge on flight decks and cockpits
4. To impart knowledge about the navigation systems
5. To gain more knowledge on air data systems and autopilot

Unit	Description	Instructional Hours
I	**INTRODUCTION TO AVIONICS** Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems. Design, technologies.	9
II	**DIGITAL AVIONICS ARCHITECTURE** Avionics system architecture – data buses – MIL-STD-1553B – ARINC – 429 – ARINC – 629.	9
III	**FLIGHT DECKS AND COCKPITS** Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.	9
IV	**INTRODUCTION TO NAVIGATION SYSTEMS** Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.	9
V	**AIR DATA SYSTEMS AND AUTO PILOT** Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Knowledge of avionics sub systems used in civil and military aircrafts.
CO2: Ability to build Digital avionics architecture
CO3: Ability to design flight decks and cockpits
CO4: Ability to design Navigation system
CO5: Ability to design and perform analysis on air system

TEXT BOOKS:

T1 - Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004
T2 - Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 1996.

REFERENCE BOOKS:

R1 - Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
R2 - Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993.
R3 - Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Longman Scientific

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7202	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3

Course Objective

1. To introduce Governing Equations of viscous fluid flows
2. To introduce the grid generation techniques
3. To enable the students to understand the various discretization methods.
4. To enable the students to understand the solution procedures and turbulence modeling
5. To create confidence to solve the complex problems using finite volume techniques

Unit	Description	Instructional Hours
I	**FUNDAMENTAL CONCEPTS** Introduction – Governing equations of Fluid Dynamics - Incompressible In viscid Flows: Source, vortex and doublet panel, methods - lifting flows over arbitrary bodies. Mathematical properties of Fluid Dynamics Equations -_ Elliptic, Parabolic and Hyperbolic equations - Well posed problems - discretization of partial Differential Equations.	10
II	**GRID GENERATION** Grids- Classification of grids and transformations. Generation of structured grids. Unstructured grids. Delany triangulation, Advanced front technique.	7
III	**DISCRETIZATION** Discretization and its importance, Boundary layer Equations and methods of solution -Implicit time dependent methods for inviscid and viscous compressible flows - Concept of numerical dissipation – Stability properties of explicit and implicit methods - Conservative upwind discretization for Hyperbolic systems - Further advantages of upwind differencing. Explicit and implicit method for subsonic and supersonic flows.	8
IV	**FINITE ELEMENT TECHNIQUES** Overview of Finite Element Techniques in Computational Fluid Dynamics. History of finite element techniques. Strong and Weak Formulations of a Boundary Value Problem.	6
V	**FINITE VOLUME TECHNIQUES** Finite Volume Techniques - Cell Centered Formulation - Lax - Vendoroff Time Stepping - Runge - Kutta Time Stepping - Multi - stage Time Stepping - Accuracy - Cell Vertex Formulation - Multistage Time Stepping - FDM -like Finite Volume Techniques – Central and Up-wind Type Discretizations - Treatment of Derivatives. Flux – splitting schemes. Pressure correction solvers – SIMPLE, PESO.	14
	Total Instructional Hours	**45**

Course Outcome

CO1: To create numerical modeling and its role in the field of fluid flow and heat transfer
CO2: To learn the various grid generating techniques.
CO3: To use the various discretization methods and boundary layer equations.
CO4: To learn the various solution methods used in finite element techniques.
CO5: To learn the solution procedures and turbulence modeling to solve flow and heat transfer problems

TEXT BOOKS:

T1 - Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Vols. I and II, Springer - Verlag, Berlin, 1988.
T2 - John F. Wendt (Editor), "Computational Fluid Dynamics - An Introduction", Springer – Verlag, Berlin, 1992

REFERENCE BOOKS:

R1 - Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. I and II,John Wiley & Sons, New York, 1988.
R2 - Klaus A Hoffmann and Steve T. Chiang, "Computational Fluid Dynamics for Engineers", Vols. I & II Engineering Education System, P.O. Box 20078, W. Wichita,K.S., 67208 - 1078 USA, 1993.
R3 - Anderson, Jr.D., "Fundamentals of Aerodynamics", McGraw-Hill, 2000.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7001	AERO ENGINE AND AIRFRAME LABORATORY	0	0	4	2

Course Objective

1. To introduce the knowledge of the maintenance procedures followed for overhaul of aero engines.
2. To introduce the knowledge of the repair procedures followed for overhaul of aero engines.
3. To study about welding of aircraft components.

Expt. No.	Description of the Experiments
1.	gine (Piston Engine) - cleaning, visual inspection, NDT checks.
2.	Engine starting procedures.
3.	Study of Camshaft operation, firing order and magneto, study of carburetor and valve timing.
4.	Study of lubrication and cooling system Piston Engine.
5.	Riveted patch repairs.
6.	Tube bending and flaring
7.	:et metal forming
8.	Study on MIG, TIG & PLASMA welding of aircraft components
9.	Welded patch repair
10.	Aircraft wood gluing-Single scarf joint and Double scarf joint

Total Practical Hours 45

Course Outcome

CO1: Ability to maintain the aero engines.
CO2: Ability to repair the aero engines.
CO3: Knowledge in overhaul of aero engines.
CO4: Ability to perform welding of aircraft components.
CO5: Knowledge of the aircraft joints.

List of Equipment (for a batch of 30 students)

Sl. No.	Equipments	Qty.
1	Aircraft Piston engines	1
2	Set of basic tools for dismantling and assembly	1 set
3	NDT equipment	1 set
4	Micrometers, depth gauges, Vernier calipers	2 sets
5	Valve timing disc	1
6	Shear cutter pedestal type	1
7	Drilling Machine	1
8	Bench Vices	1
9	Radius Bend bars	1
10	Pipe Flaring Tools	1
11	Welding machine	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7002	AVIONICS LABORATORY	0	0	4	2

Course Objective

1. This laboratory is to train students, to study about basic digital electronics circuits, various microprocessor applications in Control surface.
2. To study about displays fault tolerant computers.
3. To study the stability analysis and design using MATLAB.

Expt. No.	Description of the Experiments
1.	Addition/Subtraction of 8 bit and 16 bit data for control surface deflection.
2.	Sorting of Data in Ascending & Descending order for voting mechanism.
3.	Sum of a given series with and without carry for identifying flap data
4.	Greatest in a given series & Multi-byte addition in BCD mode.
5.	Addition/Subtraction of binary numbers using adder and Subtractor circuits.
6.	Multiplexer & Demultiplexer Circuits
7.	Encoder and Decoder circuits.
8.	Stability analysis using Root locus, Bode plot techniques.
9.	Design of lead, lag and lead –lag compensator for aircraft dynamics
10.	Performance Improvement of Aircraft Dynamics by Pole placement technique.
	Total Practical Hours **45**

Course Outcome

CO1: Ability to write the programme for control surface deflection.
CO2: Ability to use microprocessor in Flight control.
CO3: Ability to understand digital electronics circuits.
CO4: Ability to perform stability analysis
CO5: Knowledge of the design of avionic systems using MATLAB

List of Equipment (for a batch of 30 students)

S.No.	Details of Equipments	Quantity	Experiment Nos.
1.	Microprocessor 8085 Kit	10	1,2,3,4
2.	Adder/Subtractor Binary bits Kit	10	5
3.	Encoder Kit	10	7
4.	Decoder Kit	10	7
5.	Multiplexer Kit	10	6
6.	Demultiplexer Kit	10	6
7.	computers	10	8,9,10
8.	Regulated power supply*	10	5,6,7
9.	MATLAB software	-	8,9,10

*Is not needed when regulated power supply is in built.

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PROFESSIONAL ELECTIVE-III

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7301	VIBRATIONS AND ELEMENTS OF AEROELASTICITY	3	0	0	3

Course Objective

1. To study the effect of time dependent forces on mechanical systems
2. To learn the Eigen value and vector problems
3. To get the natural characteristics of continuous system.
4. To Familiarize with the Approximate Methods
5. To study the Aeroelastic effects of aircraft wing.

Unit	Description	Instructional Hours
I	**SINGLE DEGREE OF FREEDOM SYSTEMS** Introduction to simple harmonic motion, D'Alembert's principle, free vibrations, forced vibrations – with and without damping – support excitation – transmissibility – vibration measuring instruments.	10
II	**MULTI DEGREES OF FREEDOM SYSTEMS** Two degrees of freedom systems - static and dynamic couplings - vibration absorber- principal co-ordinates - principal modes and orthogonal conditions - Eigen value problems - Lagrangean equations and application.	10
III	**CONTINUOUS SYSTEMS** Vibration of elastic bodies - vibration of strings – longitudinal, lateral and torsional vibrations	8
IV	**APPROXIMATE METHODS** Approximate methods - Rayleigh's method - Dunkerlay's method – Rayleigh-Ritz method, Holzer method, matrix iteration method.	9
V	**ELEMENTS OF AEROELASTICITY** Vibration due to coupling of bending and torsion - Aeroelastic problems - Collars triangle - wing divergence - aileron control reversal – flutter – buffeting. – elements of servo elasticity	8
	Total Instructional Hours	**45**

Course Outcome

CO1.	Gaining understanding of single
CO2.	Ability to solve multi-degree vibrating systems
CO3.	Blast to continuous systems
CO4.	Ability to use numerical techniques for vibration problems
CO5.	Knowledge acquired in aero elasticity and fluttering

TEXT BOOKS:

T1 - Timoshenko S., "Vibration Problems in Engineering"– John Wiley and Sons, New York, 1993.
T2 - V. P. Singh, 'Mechanical Vibrations', Fourth Edition, Dhanpat Rai and Co., 2014.

REFERENCE BOOKS:

R1 - Grover. G.K., "Mechanical Vibrations", 7th Edition, Nem Chand Brothers, Roorkee, India, 2003
R2 - Bisplinghoff R.L., Ashely H and Hogman R.L., "Aeroelasticity", Addision Wesley Publication, New Tork, 1983.
R3 - Singiresu S. Rao, 'Mechanical Vibrations', Fifth Edition, Prentice Hall, 2011.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7302	SATELLITE PROPULSION	3	0	0	3

Course Objective

1. To know types of satellite propulsion with respect to Indian & international scenario
2. To understand the orbital transfer of satellites
3. To analyze the various thrusters for satellites
4. To enrich their knowledge in the control of spacecraft.
5. To select suitable materials

Unit	Description	Instructional Hours
I	**INTRODUCTION TO SATELLITE PROPULSION** Introduction – Classification of space propulsion– Mission requirements –Mission analysis- Current status of Indian rocket programme with respect to international scenario	8
II	**BASICS OF SATELLITE PROPULSION** Approximate ΔV for Low-Thrust Spiral Climb- Re-positioning in Orbits-Brophy's Theory- Thrust Calculation -Numerical Problems.	10
III	**THRUSTERS FOR SPACE PROPULSION** Chemical Thrusters for In-Space Propulsion-Bipropellant Chemical Thrusters and Chemical Propulsion Systems Consideration (Valving. Tanks. etc.)- Small Solid Propellant Rockets for In-space Propulsion-Electrostatic Thrusters-Hall Thruster-Electrostatic versus Electromagnetic Thrusters-Colloidal Engines- solar- Hall Thruster Efficiency- Electric Propulsion	12
IV	**CONTROL OF SATELLITES** Satellite Vector Control – Methods. Thrust determination. - Orbit Optimization - Orbit Separation Dynamics - Separation Techniques, Types of aerodynamics control in satellite	8
V	**MATERIALS FOR SATELLITE** Selection of Materials - Special Requirements of Materials to Perform under Adverse Conditions.	7
	Total Instructional Hours	**45**

Course Outcome

CO1.	Understanding evolution of satellite propulsion
CO2.	Understanding separation techniques of satellite
CO3.	Identify suitable thrusters for satellites
CO4.	Knowledge on control of satellites
CO5.	Ability to identify suitable materials for satellites

TEXT BOOKS:

T1 - Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W., Freeman & Co. Ltd., London, 1982.
T2 - Charles D. Brown., " Spacecraft Propulsion", AIAA, 1996

REFERENCE BOOKS:

R1 - Parket, E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 1982.
R2 - Vincent L. Pisacane., "Fundamentals of Space Systems", Oxford University Press, 2005
R3 - Martin J. L. Turner., "Rocket and Spacecraft Propulsion", Springer Science & Business Media, 2008.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7303	ROCKETS AND MISSILES	3	0	0	3

Course Objective

1. To know types of rockets and missiles with respect to Indian & international scenario
2. To enrich their knowledge in the area of missile and rocket flight.
3. To understand space and gravity
4. To know the staging of rockets
5. To select materials for the rockets

Unit	Description	Instructional Hours
I	**CLASSIFICATION OF ROCKETS AND MISSILES** Various methods of classification of missiles and rockets – Basic aerodynamic characteristics of surface to surface, surface to air, air to surface and air to air missiles – Examples of various Indian space launch vehicles and missiles – Current status of Indian rocket programme with respect to international scenario	10
II	**AERODYNAMICS OF ROCKETS AND MISSILES** Airframe Components of Rockets and Missiles - Forces Acting on a Missile While Passing Through Atmosphere Classification of Missiles - methods of Describing Aerodynamic Forces and Moments - Lateral Aerodynamic Moment - Lateral Damping Moment and Longitudinal Moment of a Rocket - lift and Drag Forces - Drag Estimation - Body Upwash and Downwash in Missiles - Rocket Dispersion - Numerical Problems.	10
III	**ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD** Introduction – Kepler's laws of planetary motion - One Dimensional and Two Dimensional rocket Motions in Free Space and Homogeneous Gravitational Fields - description of Vertical, Inclined and Gravity Turn Trajectories - Determination of range and Altitude Simple Approximations to Burnout Velocity.	10
IV	**STAGING AND CONTROL OF ROCKETS AND MISSILES** Rocket Vector Control – Methods, SITVC termination, Thrust determination, Multi staging of rockets - Vehicle Optimization - Stage Separation Dynamics - Separation Techniques, Types of aerodynamics control in missiles	10
V	**MATERIALS FOR ROCKETS AND MISSILES** Selection of Materials - Special Requirements of Materials to Perform under Adverse Conditions.	5
	Total Instructional Hours	**45**

Course Outcome

CO1: Knowledge to classify rockets and missiles
CO2: Understanding aerodynamics of rocket and missiles
CO3: Abilty to analyse the motion of rockets
CO4: Knowledge on stages and control of rockets & missiles
CO5: Select suitable materials for various systems

TEXT BOOKS:

T1 - Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 1993.
T2 - Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W., Freeman & Co. Ltd., London, 1982.

REFERENCE BOOKS:

R1 - Mathur, M., and Sharma, R.P., "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi 1998.
R2 - Parket, E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 1982
R3 - J. Ras.,"Design of Space and Missile Rocket Engines", CreateSpace Independent Publishing Platform, 2016

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7304	AIRFRAME MAINTENANCE AND REPAIR	3	0	0	3

Course Objective

1. To make the students to understand the Airframe components and the tools used to maintain the components.
2. Understanding on plastics used in aircrafts.
3. To know how to jack, rig and assembles the aircrafts' components.
4. To know the various components used in hydraulic and pneumatic system.
5. To identify the methods to carry out investigation and the detailed maintenance and practice procedures.

Unit	Description	Instructional Hours
I	**WELDING AND SHEET METAL REPAIR AND MAINTENANCE** Equipments used in welding shop and their maintenance – Ensuring quality welds –Welding jigs and fixtures – Soldering and brazing- Inspection of damage – Classification – Repair or replacement – Sheet metal inspection –N.D.T. Testing – Riveted repair design. Damage investigation – reverse technology.	10
II	**PLASTICS AND COMPOSITES IN AIRCRAFT** Review of types of plastics used in airplanes – Maintenance and repair of plastic components – Repair of cracks, holes etc., and various repair schemes – Scopes.Inspection and Repair of composite components – Special precautions – Autoclaves.	9
III	**AIRCRAFT JACKING, ASSEMBLY AND RIGGING** Airplane jacking and weighing and C.G. Location-Balancing of control surfaces –Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.	9
IV	**REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM** Trouble shooting and maintenance practices – Service and inspection. – Inspection and maintenance of landing gear systems. – Inspection and maintenance of air-conditioning and pressurization system, water and waste system. Installation and maintenance of Instruments – handling – Testing – Inspection. Inspection and maintenance of auxiliary systems – Fire protection systems – Ice protection system – Rain removal system –Position and warning system – Auxiliary Power Units (APUs)	10
V	**SAFETY PRACTICES** Hazardous materials storage and handling, Aircraft furnishing practices – Equipments. Trouble shooting - Theory and practices.	7
	Total Instructional Hours	**45**

Course Outcome

CO1. Ability to identify the airframe components
CO2. Skill to repair the plastic components in aircraft.
CO3. Capability to do jack, rig the aircraft
CO4. Analyze the system for defect investigation and repair it.
CO5. Ability to perform investigation skill to maintain the airframe with safety.

TEXT BOOKS:

T1 - Kroes, Watkins, Delp, "Aircraft Maintenance and Repair", McGraw-Hill, New York, 1992.
T2 - Delp, Bent and McKinley "Aircraft Maintenance Repair", McGraw Hill, New York, 1987.

REFERENCE BOOKS:

R1 - Larry Reithmeir, "Aircraft Repair Manual", Palamar Books, Marquette, 1992.
R2 - Brimm D.J. Bogges H.E., "Aircraft Maintenance", Pitman Publishing corp. New York,1940
R3 - A&P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996.

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PROFESSIONAL ELECTIVE-IV

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7305	EXPERIMENTAL STRESS ANALYSIS	3	0	0	3

Course Objective

1. To bring awareness on experimental method of finding the response of the structure to different types of load.
2. Ability to analyze experimental data and develop appropriate, logical conclusions based on comparisons to theoretical results and other experimental evidence.
3. Detailed knowledge about the photo elastic materials and their testing.
4. Use of failure theories to analyze the failure pattern in different materials.
5. To know about the various non-destructive testing methods

Unit	Description	Instructional Hours
I	**EXTENSOMETERS AND DISPLACEMENT SENSORS** Principles Of Measurements - Accuracy, Sensitivity and Range Of Measurements – Mechanical – Optical - Acoustical and Electrical Extensometers and Their Uses - Advantages and Disadvantages - Capacitance Gauges.	8
II	**ELECTRICAL RESISTANCE STRAIN GAUGES** Principle Of Operation and Requirements - Types and Their Uses -Materials For Strain Gauges - Calibration and Temperature Compensation - Cross Sensitivity - Wheatstone Bridge and Potentiometer Circuits For Static and Dynamic Strain Measurements - Strain Indicators - Rosette Analysis	10
III	**PHOTOELASTICITY** Two Dimensional Photo Elasticity - Photo Elastic Materials - Concept Of Light - Photoelastic Effects - Stress Optic Law - Transmission Photoelasticity - Plane and Circular Polariscopes - Interpretation Of Fringe Pattern - Calibration Of Photoelastic Materials - Compensation and Separation Techniques - Introduction To Three Dimensional Photo Elasticity.	10
IV	**BRITTLE COATING AND MOIRE TECHNIQUES** Relation Between Stresses In Coating And Specimen - Use Of Failure Theories In Brittle Coating - Moire Method Of Strain Analysis.	8
V	**NON – DESTRUCTIVE TESTING** Fundamentals Of NDT - Acoustic Emission Technique – Radiography – Thermography – Ultrasonics - Eddy Current Testing - Fluorescent Penetrant Testing - Magnetic Particle Inspection - Guided Wave Testing - Electromagnetic Testing.	9
	Total Instructional Hours	**45**

Course Outcome

1. Measurement of strain in structures using mechanical and other means.
2. Measurement of strain in structures using electrical strain gauges.
3. Knowledge in testing and evaluation of stress in photoelastic materials.
4. Calculation of failure stress in coatings using different failure theories.
5. Extensive knowledge in using non-destructive testing for testing purpose.

TEXT BOOKS:

T1 - Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., "Experimental Stress Analysis", Tata McGraw-Hill, New Delhi, 1984.
T2 - Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 1996.

REFERENCE BOOKS:

R1 - Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw-Hill Inc., NewYork, 2005. IV edition.
R2 - Max Mark Frocht, "Photo Elasticity", John Wiley and Sons Inc., New York, 1968.
R3 - Durelli, A.J., "Applied Stress Analysis", Prentice Hall of India Pvt Ltd., New Delhi, 1970.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7306	HELICOPTER THEORY	3	0	0	3

Course Objective

1. To make the student familiarize with the principals involved in helicopters.
2. To understand the aerodynamics of helicopter rotor blade
3. To gain knowledge in various power plants equipped in helicopter
4. To study the performance and stability aspects of Helicopter under different operating conditions
5. To understand the source and control of helicopter vibration.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Helicopter as an aircraft, Basic features, Layout, Configuration, Generation of lift, lead-lag, flapping and feathering motion, Rotor controls and various types of rotor, Blade loading, Effect of solidity - Blade area required, number of Blades, Power losses, Rotor efficiency.	9
II	**AERODYNAMICS OF ROTOR BLADE** Aerofoil characteristics in forward flight, Hovering and Vortex ring state, Blade stall, maximum lift of the helicopter - calculation of Induced Power, High speed limitations; profile and parasite drag , power loading, ground effect	9
III	**POWER PLANTS AND FLIGHT PERFORMANCE** Piston engines, Gas turbines, Ramjet principle, Comparative performance, Power required, Range and Endurance, Rate of Climb, Best Climbing speed, Ceiling in vertical climb, Autorotation.	9
IV	**STABILITY AND CONTROL** Physical description of effects of disturbances, Stick fixed Longitudinal and lateral dynamic stability, lateral stability characteristics, control response. Differences between stability and control of airplane and helicopter.	9
V	**ROTOR VIBRATIONS** Dynamic model of the rotor, Motion of the rigid blades, Properties of vibrating system, phenomenon of vibration, vibration absorbers, Measurement of vibration in flight, Rotor Blade design: General considerations, Airfoil selection, Blade construction, Materials, Factors affecting weight and cost, Design conditions, Stress analysis.	9
	Total Instructional Hours	**45**

Course Outcome

CO1. Perform the Aerodynamics calculation of Rotor blade
CO2. Calculate the power components of helicopter blade
CO3. Compare the performance of power plants
CO4. Perform stability and control characteristics of Helicopter
CO5. Control the vibration on helicopter.

TEXT BOOKS:

T1 - John Fay, "The Helicopter and How It Flies", Himalayan Books 1995
T2 - Lalit Gupta, "Helicopter Engineering", Himalayan Books New Delhi 1996

REFERENCE BOOKS:

R1 - Joseph Schafer, "Basic Helicopter Maintenance", Jeppesen 1980
R2 - R W Prouty, "Helicopter Aerodynamics"
R3 - Wayne Johnson "Helicopter Theory",Dover Publications,Inc., New York,1980.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7307	AIRCRAFT DESIGN	3	0	0	3

Course Objective

1. To familiarize students with the important issues and methodologies of aircraft design.
2. To make the students to understand the conceptual design of aircraft.
3. To understand the importance of aircraft design characteristics on performance.
4. To familiarize the students with the design and selection of controls in aircraft
5. To illustrate the process of aircraft synthesis as an outcome of the integration of the disciplines of aerodynamics, performance, stability and control, propulsion, structures and aero elasticity.

Unit	Description	Instructional Hours
I	**REVIEW OF DEVELOPMENTS IN AVIATION** Categories and types of aircrafts – various configurations – Layouts and their relative merits –strength, stiffness, fail safe and fatigue requirements – Manoeuvering load factors – Gust and manoeuverability envelopes – Balancing and maneuvering loads on tail planes.	9
II	**POWER PLANT TYPES AND CHARACTERISTICS** Characteristics of different types of power plants – Propeller characteristics and selection –Relative merits of location of power plant.	9
III	**PRELIMINARY DESIGN** Selection of geometric and aerodynamic parameters – Weight estimation and balance diagram –Drag estimation of complete aircraft – Level flight, climb, takeoff and landing calculations – range and endurance – static and dynamic stability estimates – control requirements.	9
IV	**SPECIAL PROBLEMS** Layout peculiarities of subsonic and supersonic aircraft – optimization of wing loading to achieve desired performance – loads on undercarriages and design requirements.	9
V	**STRUCTURAL DESIGN** Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections and joints. Materials for modern aircraft – Methods of analysis, testing and fabrication.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Conduct trade-off between the conflicting demands of different disciplines by performing a detailed preliminary design of a complete aircraft.
CO2: Select the appropriate power plant for the aircraft
CO3: Design the control surfaces based on the stability requirements and to select the wing planform based on the mission requirements.
CO4: Estimate weight, wing loading and other performance parameters related to conceptual design of a complete aircraft.
CO5: Identify design features of aerospace structures, and calculate load factors.

TEXT BOOKS:

T1 - D.P. Raymer, "Aircraft conceptual design", AIAA Series, 1988.
T2 - G. Corning, "Supersonic & Subsonic Airplane design", II Edition, Edwards Brothers Inc.,Michigan, 1953.

REFERENCE BOOKS:

R1 - E. Torenbeek, "Synthesis of Subsonic Airplane design", Delft University Press, London,1976.
R2 - A.A. Lebedenski, "Notes on airplane design", Part-I, I.I.Sc., Bangalore, 1971.
R3 - Houghton, E.L., and Caruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7308	ENGINE SYSTEM AND CONTROL	3	0	0	3

Course Objective

1. To understand the basic components of aircraft engine.
2. To give an exposure to the different systems in Aircraft Engines.
3. To enumerate various safety procedures and maintenance equipment
4. To exposure the methodologies of various instruments used for engine controls & indication.
5. To know the knowledge of the various instruments used in engine

Unit	Description	Instructional Hours
I	**ENGINE CONSTRUCTION** Layout – Piston Engine – Turbo Prop-Gas Turbine Engines – Modular concept. Auxiliary system of gas turbine engine– Fuel systems – Heat Management system. Lubricants and Fuel used – Engine Materials – Compressor. Turbine. Frames and Casting etc.	10
II	**ENGINE SYSTEMS** Hydraulic and pneumatic systems– Engine controls – FADEC Fire Protection System – Ignition and Starting system – Engine Anti-icing system. Thrust augmentation- thrust vectoring-reversal.	9
III	**MAINTENANCE & INSPECTION** Maintenance aspects of Gas Turbine Engines – Preventive condition Monitoring – Boroscopic Inspection. on conditioning monitoring – On wing Trim Balance – Test bed overhaul.	6
IV	**CONTROL INSTRUMENTS** Engine sensors – Basic construction – Processing signals – Analog and Digital Indication – Scaling – Monitoring of Instruments / Indicators.	10
V	**ENGINE INSTRUMENTS** Primary instruments – Tachometer. Fuel flow. Exhaust Gas Temperature. Thrust parameters – Secondary Instruments – Vibration indicator. Oil Pressure and Oil Temperature indictor. Nacelle Temperature Indicator.	10
	Total Instructional Hours	**45**

Course Outcome

CO1. Understand the basic components of aircraft engine.
CO2. Know the operation of different systems in Aircraft Engines.
CO3. Ability to identify the engine instruments and maintenance of engine.
CO4. Knowledge to develop the various instruments used for engine controls & indication.
CO5. Identify the problem occurs in engine instruments and control the engine instruments.

TEXT BOOKS:

T1 - Aircraft Instruments – E H J Pallett. Pitman & Co., 1993.
T2 - Aircraft Gas Turbine Engine Technology – Irwin E Treager. English Book Stores. New Delhi.

REFERENCE BOOKS:

R1 - "General Hand Book of Airframe and Power Plant" US Department of Transportation. FAA. English Book Stores. New Delhi.
R2 - Aircraft Gas Turbine Guide. P&W Publications. English Book Stores. New Delhi.
R3 - Aircraft Gas Turbine and Operation – PRATT AND WHITENY. United Technologies. English Book Stores. New Delhi.

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PROFESSIONAL ELECTIVE-V

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE8301	FATIGUE AND FRACTURE	3	0	0	3

Course Objective

1. To understand the basic concepts involved in fatigue structures.
2. To know the various behavior of fatigue.
3. To learn about the various aspects of fatigue.
4. To understand the mechanics of fracture.
5. To study the importance of fracture mechanics in aerospace applications.

Unit	Description	Instructional Hours
I	**FATIGUE OF STRUCTURES** S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves – Fatigue of composite materials.	7
II	**STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR** Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques -Cumulative damage - Miner's theory - Other theories.	10
III	**PHYSICAL ASPECTS OF FATIGUE** Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.	10
IV	**FRACTURE MECHANICS** Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials - stress analysis of cracked bodies - Effect of thickness on fracture toughness.	10
V	**FATIGUE DESIGN AND TESTING** Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.	8
	Total Instructional Hours	**45**

Course Outcome

CO1. Understands how fatigue occurs in structures.
CO2. Analyze the type of various aspects of fatigue behavior.
CO3. Access the different types of cracks on components.
CO4. Skill to perform on fatigue design.
CO5. Ability to analyze the fracture due to fatigue.

TEXT BOOKS:

T1 - Prasanth Kumar, "Elements of fracture mechanics", Wheeter publication, 1999.
T2 - Barrois W, Ripely, E.L., "Fatigue of aircraft structure," Pergamon press. Oxford, 1983.

REFERENCE BOOKS:

R1 - Knott, J.F., "Fundamentals of Fracture Mechanics," - Buterworth & Co., Ltd., London, 1983.
R2 - Kare Hellan ,'Introduction to Fracture Mechanics', McGraw Hill, Singapore,1985.
R3 - Sih C.G., "Mechanics of fracture." Vol - I, Sijthoff and w Noordhoff International Publishing Co.,Netherlands, 1989.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE8302	PROFESSIONAL ETHICS (Only for AERO)	3	0	0	3

Course Objective

1. To introduce the basic of professional ethics.
2. To create an awareness on engineering ethics.
3. To understand social experimentation of an engineer.
4. To understand social responsibility, rights and safety of an engineer.
5. To appreciate ethical dilemma in discharging duties in professional life

Unit	Description	Instructional Hours
I	**INTRODUCTION TO PROFESSIONAL ETHICS** Ethics in Workplace - Formulation of Ethics - Managerial Ethics - Managing Ethical Behaviour - Codes of Ethics - Encouraging Ethical Behaviour - Ethical Leadership - Ethical Decision making- Corporate Social Responsibility (CSR) - Intellectual Property Rights (IPR)- Meaning- Laws relating to Intellectual Property Rights (IPRs)	10
II	**MORAL ISSUES AND ETHICAL THEORIES** Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas – moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories. Valuing Time – Co-operation – Commitment.	9
III	**ENGINEERING AS SOCIAL EXPERIMENTATION** Engineering as experimentation – Engineers as Responsible Experimenters – Research Ethics – Codes ofEthics – Industrial Standards – A Balanced Outlook on Law – The Challenger Case Study	8
IV	**ENGINEER'S RESPONSIBILITY, RIGHTS AND SAFETY** Safety and Risk – Assessment of Safety and Risk – Risk benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk – Chernobyl Case and Bhopal Case studies. Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of interest – Occupational Crime – Professional Rights – Employee Rights	10
V	**GLOBAL ISSUES OF ENGINEERING ETHICS** Multinational Corporations – Business Ethics – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors -moral leadership.	8
	Total Instructional Hours	**45**

Course Outcome

CO1. Knowledge of professional ethics.
CO2. Ability to apply ethics in society.
CO3. Ability to discuss the ethical issues related to engineering.
CO4. Ability to realize the responsibilities.
CO5. Have knowledge on rights in the society.

TEXT BOOKS:

T1 - Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata Mc Graw Hill, New Delhi.
T2 - Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics Concepts and Cases", Thompson Learning, 2000.003.

REFERENCE BOOKS:

R1 - Charles D Fleddermann, " Engineering Ethics", Prentice Hall, New Mexico, 1999.
R2 - John R Baatright, "Ethics and the Conduct of Business", Pearson Education 2003.
R3 - Edmund G Seeabauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers",Oxford University press 2001.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE8303	SPACE MECHANICS	3	0	0	3

Course Objective

1. To introduce concepts of orbital mechanics.
2. Categorize the bodies with respect to position and time.
3. To know the concept of satellite injection.
4. To identify the trajectory computation for interplanetary travel.
5. To know the fundamental flight of ballistic missiles.

Unit	Description	Instructional Hours
I	**BASIC CONCEPTS** The Solar System – References Frames and Coordinate Systems – The Celestial Sphere – The Ecliptic – Motion of Vernal Equinox – Side real Time–Solar Time–Standard Time–The Earth's Atmosphere.	7
II	**THE GENERAL N-BODY PROBLEM** The many body Problem – Lagrange – Jacobian Identity –The Circular Restricted Three Body Problem – Liberation Points- Relative Motion in the N-body Problem –Two Body Problem – Satellite Orbits – Relations Between Position and Time – Orbital Elements.	10
III	**SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS** General Aspects of satellite Injections – Satellite Orbit Transfer –Various Cases – Orbit Deviations Due to Injection Errors – Special and General Perturbations – Cowell's Method – Encke's Method – Method of vibrations of Orbital Elements.	10
IV	**INTERPLANETARY TRAJECTORIES** Two Dimensional Interplanetary Trajectories –Fast Interplanetary Trajectories – Three Dimensional Interplanetary Trajectories – Launch if Interplanetary Spacecraft –Trajectory about the Target Planet.	8
V	**BALLISTIC MISSILE TRAJECTORIES AND MATERIALS** The Boost Phase – The Ballistic Phase –Trajectory Geometry- Optimal Flights – Time of Flight – Re – entry Phase – The Position of the Impact Point – Influence Coefficients. Space Environment – Peculiarities – Effect of Space Environment on the Selection of Spacecraft Material.	10
	Total Instructional Hours	**45**

Course Outcome

CO1. Understands the basic concepts of space.
CO2. Skill to locate the bodies' position in space with respect to time.
CO3. Ability to perform satellite injection, satellite perturbations.
CO4. Capability to find the interplanetary trajectories
CO5. Apply the orbital mechanics to control the missiles.

TEXT BOOKS:

T1 - Cornelisse, J.W., "Rocket Propulsion and Space Dynamic", W.H. Freeman & Co., 1984.
T2 - Parker E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 1982.

REFERENCE BOOKS:

R1 - Sutton, G.P., "Rocket Propulsion Elements", John Wiley, 1993.
R2 - Van de Kamp, P., "Elements of Astromechanics", Pitman, 1979.
R3 - Thomas A Ward, "Aerospace Propulsion systems", John Wiley, 2010.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE8304	AVIATION MANAGEMENT AND AIR SAFETY	3	0	0	3

Course Objective

1. To enable the students to learn the development and growth of Aviation Industry
2. To understand the concept of airport management and operations
3. To learn the legal background of Aviation world
4. To know about the importance of Air safety and security measures.
5. To familiarize the students with the technological improvements in aviation safety.

Unit	Description	Instructional Hours
I	**INTRODUCTION** History of Aviation- Development of Air transportation in India- Major players in Airline Industry- Market potential of Indian Airline Industry— Current challenges in Airline Industry-Competition in Airline Industry –Role of ICAO and IATA in Air transportation	7
II	**AIRPORT MANAGEMENT AND AIRLINE OPERATIONS** **Airport Management-** Airport planning- Airport operations-Airport functions- Organization structure of Airports sectors-Airport Authorities- Global and Indian scenario of Airport management –DGCA –AAI. **Airline Operations -** Organisation Structure of Airline Sectors -Airline Terminal Management- Flight Information Counter/Reservation and Ticketing-Check In/Issue of Boarding pass-Customs and Immigration formalities-Co-ordination-Security Clearance-Baggage-Handling-Handling of Stretcher Passengers and Human Remains-Handling of CIP,VIP & VVIP- Co-ordination of Supporting Agencies /Departments – Introduction to Airport cargo management.	10
III	**AVIATION LAW AND AIRCRAFT RULES AND REGULATIONS** DGCA functions – Aircraft act 1934 – National legislation - Airport Authority of India Acts 1994 – Civil Aviation Requirements (CAR)- Section (1 to 7) – (General -Airworthiness Air Transport - Aerodrome standards and Air Traffic Services -Air Safety -Design standards and type certification - Flight crew standards, training and licensing) – Introduction to International conventions.	10
IV	**AIRTRANSPORTATION SAFETY AND SECURITY** Protecting Public Transportation -Screening- Metal Detectors -Xray Inspections, Trace- Detection Techniques. Terrorism –Introduction- Causes of Terrorism - Rival claim of pales tine- Palestine Liberation Organization - Nuclear Terrorism - Aircraft as Missiles - 9/11 Terrorist Act and its Consequences - Biological &Chemical Warfare - Steps to Combat Terrorism –Hijacking – security measures	10
V	**TECHNOLOGICAL IMPROVEMENTS ON AVIATION SAFETY AND SECURITY** Technological Improvements on Aviation Safety and Security Introduction- Microwave Holographic Imaging - Body or Fire Security Scanner - New Generation of video Security Systems –Bio simmer – Biometric Systems.	8
	Total Instructional Hours	**45**

Course Outcome

CO1. Ability to understand the role of IATA and ICAO in Air transportation
CO2. Proficiency in Airline management and Airport operations
CO3. Understand the concept of Aviation safety and security
CO4. Understand the various aviation standards in quality assurance, safety rules and regulations.
CO5. Understand Aviation laws and regulations related to each type of organization.

TEXT BOOKS:

T1 - Wells .A-Airport Planning and Management, 4th Edition-McGraw-hill, London-2000.
T2 - Aviation and Airport Security –Kathleen M. Sweet –Pearson Education Inc., Second edition, 2009.

REFERENCE BOOKS:

R1 - P.S. Senguttuvan –Fundamentals of Airport Transport Management –McGraw Hill 2003
R2 - Aircraft Manual, C.A.R. Sec. II
R3 - "Fundamentals of Air Traffic Control" Michael S. Nolan, Cengage Learning.

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PROFESSIONAL ELECTIVE-VI

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE8305	STRUCTURAL DYNAMICS	3	0	0	3

Course Objective

1. Learn how to model discrete single-degree and multiple-degree vibratory systems
2. To calculate the free and forced response of mechanical systems.
3. To develop the equations of motion for vibratory systems.
4. Learn to use finite element methods for the analysis of the vibrations of structures.
5. To study the dynamics response by using approximate methods.

Unit	Description	Instructional Hours
I	**FORCE-DEFLECTION PROPERTIES OF STRUCTURES** Constraints and Generalized coordinates – Virtual work and generalized forces – Force – Deflection influence functions – stiffness and flexibility methods.	12
II	**PRINCIPLES OF DYNAMICS** Free and forced vibrations of systems with finite degrees of freedom – Damped oscillations – D"Alembert's principle – Hamilton's principle – Lagrangean equations of motion and applications.	9
III	**NATURAL MODES OF VIBRATION** Equations of motion for free vibrations Solution of Eigen value problems – Normal coordinates and orthogonality relations.	10
IV	**ENERGY METHODS** Rayleigh's principle – Rayleigh – Ritz method – Coupled natural modes – Effect of rotary inertia and shear on lateral vibrations of beams – Natural vibrations of plates.	8
V	**APPROXIMATE METHODS** Approximate methods of evaluating the Eigen frequencies and the dynamics response of continuous systems – Matrix methods of dynamic stress analysis.	6
	Total Instructional Hours	**45**

Course Outcome

CO1: To understand single and multi-degree vibrating systems
CO2: To identify, formulate and solve engineering problems.
CO3: Ability to develop the equations of motion for vibratory systems and solving for the free and forced response.
CO4: Capability to use numerical techniques for vibration problems
CO5: To analyze and modify a vibratory structure in order to achieve specified requirements.

TEXT BOOKS:

T1 - F.S.Tse, I.E. Morse and H.T. Hinkle, "Mechanical Vibration", Prentice Hall of India Pvt., Ltd., New Delhi, 1988.
T2 - S.P. Timoshenko and D.H. Young, "Vibration Problems in Engineering", John Willey & Sons Inc., 1984.

REFERENCE BOOKS:

R1 - Von. Karman and A.Biot, "Mathematical Methods in Engineering", McGraw-Hill Book Co., New York, 1985.
R2 - Craig R.R. Jr., Structural Dynamics – An Introduction to Computer Methods, John Wiley and Sons, 1981.
R3 - R.K. Vierck, "Vibration Analysis", 2nd Edition, Thomas Y. Crowell & Co., Harper & Row Publishers, New York, U.S.A., 1989.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE8306	UAV SYSTEMS	3	0	0	3

Course Objective

1. To introduce the basic of UAV.
2. To impart knowledge about the design of UAV systems.
3. To gain more knowledge on avionics hardware.
4. To impart knowledge about the communication payloads and controls.
5. To study about the development of UAV systems.

Unit	Description	Instructional Hours
	INTRODUCTION TO UAV	
I	History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications.	9
	THE DESIGN OF UAV SYSTEMS	
II	Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations-Characteristics of Aircraft Types- Design Standards and Regulatory Aspects-UK,USA and Europe-Design for Stealth--control surfaces-specifications.	9
	AVIONICS HARDWARE	
III	Autopilot – AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration, and testing.	9
	COMMUNICATION PAYLOADS AND CONTROLS	
IV	Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-trouble shooting.	9
	THE DEVELOPMENT OF UAV SYSTEMS	
V	Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing-Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.	9
	Total Instructional Hours	**45**

Course Outcome

CO1. Knowledge of classification, models, prototypes and applications of UAV
CO2. Ability to design UAV systems
CO3. Ability to design avionics hardwares
CO4. Ability to use different communication payloads and controls
CO5. Knowledge of the development of UAV systems

TEXT BOOKS:

T1 - Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
T2 - Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

REFERENCE BOOKS:

R1 - Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
R2 - Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001
R3 - Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE8307	EXPERIMENTAL AERODYNAMICS	3	0	0	3

Course Objective

1. To provide details, operating principles and limitations of forces, pressure, velocity and temperature measurements.
2. To understand the principles behind the wind tunnel balancing
3. To describe flow visualization techniques and to highlight in depth discussion of analog methods.
4. To gain knowledge in basic measurements techniques.
5. To estimate the errors in special flows

Unit	Description	Instructional Hours
I	**BASIC MEASUREMENTS IN FLUID MECHANICS** Need for experimental studies – Fluid mechanics measurements –Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – Flow visualization –Components of measuring systems – Importance of model studies.	7
II	**CHARACTERISTICS OF MEASUREMENTS** Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation of wind tunnels – Turbulence- Wind tunnel balance –principles, types and classifications -Balance calibration	10
III	**FLOW VISUALIZATION AND ANALOGUE METHODS** Principles of Flow Visualization – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph - Hydraulic analogy – Hydraulic jumps – Electrolytic tank.	9
IV	**PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS** Measurement of static and total pressures in low and high speed flows- Pitot-Static tube characteristics - Pressure transducers – principle and operation – Velocity measurements - Hot-wire anemometry – LDV – PIV: Temperature measurements.	9
V	**SPECIAL FLOWS AND UNCERTAINTY ANALYSIS** Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers - Data acquisition and processing – Signal conditioning - Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty analysis and calculation	10
	Total Instructional Hours	**45**

Course Outcome

CO1. Acquiring basics knowledge on aerodynamic flow and wind tunnel measurement systems
CO2. Apply knowledge in wind tunnel measurements
CO3. Learn various flow visualization techniques.
CO4. Execute specific instruments for flow parameter measurement like pressure, velocity, temperature etc.
CO5. Analyze the special flows and uncertainty problems.

TEXT BOOKS:

T1 - Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids." CRC Press – Taylor & Francis, 2007.
T2 - Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor & Francis, 2006.

REFERENCE BOOKS:

R1 - Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.Bradsaw Experimental Fluid Mechanics.
R2 - Lecture course on "Advanced Flow diagnostic techniques" 17-19 September 2008 NAL, Bangalore.
R3 - NAL-UNI Lecture Series 12: Experimental Aerodynamics, NAL SP 98 01 April 1998

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE8308	AIR TRAFFIC CONTROL AND PLANNING	3	0	0	3

Course Objective

1. To acquire knowledge about basic concepts of air traffic system
2. To study and understand about the air traffic control, procedure and air traffic service
3. To learn about various instruments used for air traffic control
4. To study the procedure of the formation of aerodrome and its design.
5. To know the various emergency services providing in the air traffic control system

Unit	Description	Instructional Hours
I	**BASIC CONCEPTS** Concepts of ATC , ATS and ATCS – Objectives of ATS – VFR & IFR operations – Classification of ATS air spaces – Varies kinds of separation – Altimeter setting procedures –Division of responsibility of control.	9
II	**AIR TRAFFIC SERVICES** Area control service, assignment of cruising levels minimum flight altitude ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time / distance – ATC clearances – Flight plans – position report	9
III	**FLIGHT INFORMATION ALERTING SERVICES, COORDINATION, EMERGENCY PROCEDURES AND RULES OF THE AIR** Basic radar terminology – Classification of radars– Identification procedures using primary /secondary radar – performance checks – use of radar in area and approach control services –co-ordination between radar / non radar control – emergencies – Flight information and advisory service – Alerting service – Co-ordination and emergency procedures.	10
IV	**AERODROME DATA, PHYSICAL CHARACTERISTICS AND OBSTACLE RESTRICTION** Aerodrome data - Basic terminology – Aerodrome reference code – Aerodrome reference point – Aerodrome elevation – Aerodrome reference temperature – Instrument runway, physical Characteristics; length of primary / secondary runway – Width of runways – Minimum distance between parallel runways etc. – obstacles restriction.	9
V	**VISUAL AIDS FOR NAVIGATION, VISUAL AIDS FOR DENOTING OBSTACLES EMERGENCY AND OTHER SERVICES** Visual aids for navigation Wind direction indicator – Landing direction indicator – Location and characteristics of signal area – Markings, general requirements – Various markings – Lights, general requirements – Aerodrome beacon, identification beacon – Simple approach lighting system and various lighting systems – VASI & PAPI - Visual aids for denoting obstacles; object to be marked and lighter – Emergency and other services.	8
	Total Instructional Hours	**45**

Course Outcome

CO1: Acquire the concept of air traffic rules and clearance procedures for airline operation.
CO2: Analyze the various air traffic data for air traffic services.
CO3: Explore the emergency procedure and air rules followed by air traffic control systems.
CO4: Understand the influence of aerodrome design factors for service establishments.
CO5: Gain the information of navigation and emergency procedures in the air traffic control systems.

TEXT BOOKS:

T1 - AIP (India) Vol. I & II, "The English Book Store", 17-1, Connaught Circus, New Delhi.
T2 - "Aircraft Manual (India) Volume I", latest Edition – The English Book Store, 17-1, Connaught Circus, New Delhi.

REFERENCE BOOKS:

R1 - "PANS – RAC – ICAO DOC 4444", Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.
R2 - "FUNDAMENTALS OF AIR TRAFFIC CONTROL" Michael S. Nolan, Cengage Learning.
R3 - Wells .A-Airport Planning and Management, 4th Edition-McGraw-hill, London-2000.

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OPEN ELECTIVE – II

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AE7402	AERODYNAMICS FOR INDUSTRIAL APPLICATIONS	3	0	0	3

Course Objective

1. To familiarize the atmosphere and effects of wind with various parameters.
2. To understand about the wind energy conversion systems and wind turbine design.
3. To learn and understand the road vehicles aerodynamics.
4. To acquire the knowledge about building aerodynamics and problems associated with tall & small building design
5. To learn the concept of effect of wake formation and special vibration issues.

Unit	Description	Instructional Hours
I	**ATMOSPHERE** Types of winds. Causes of variation of winds. Atmospheric boundary layer. Effect of terrain on gradient height. Structure of turbulent flows.	9
II	**WIND ENERGY COLLECTORS** Horizontal axis and vertical axis machines. Power coefficient. Betz coefficient by momentum theory.	9
III	**VEHICLE AERODYNAMICS** Power requirements and drag coefficients of automobiles. Effects of cut back angle. Aerodynamics of trains and Hovercraft	9
IV	**BUILDING AERODYNAMICS** Pressure distribution on low rise buildings. wind forces on buildings. Environmental winds in city blocks. Special problems of tall buildings. Building codes. Building ventilation and architectural aerodynamics.	9
V	**FLOW INDUCED VIBRATIONS** Effects of Reynolds number on wake formation of bluff shapes. Vortex induced vibrations. Galloping and stall flutter-Introduction to industrial gas turbines.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Identify the Atmospheric wind properties with various terrain fields.
CO2: Analyze the design concept of wind turbines & power efficiency.
CO3. Ability to understand the road vehicles aerodynamics in terms of drag reduction.
CO4: Understand the wind forces on buildings and architectural design parameters.
CO5: Apply the knowledge to bluff body aerodynamics and flow induced vibrations.

TEXT BOOKS:

T1 - M.Sovran (Ed). "Aerodynamics and drag mechanisms of bluff bodies and Road vehicles". Plenum press. New York. 1978.
T2 - Sachs. P.. "Winds forces in Engineering". Pergamon Press. 1978.

REFERENCE BOOKS:

R1 - Blevins. R.D.. "Flow Induced Vibrations". Van Nostrand. 1990.
R2 - Calvent. N.G.. "Wind Power Principles". Charles Griffin & Co.. London. 1979
R3 – Tony Burton. Nick Jenkins. David Sharpe and Ervin Bossanyi. "Aerodynamics of Horizontal Axis Wind Turbines" John Wiley & Sons. Ltd. 2011

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MAPPING OF COURSE OUTCOMES (COs), PROGRAM OUTCOMES (POs) AND PROGRAM SPECIFIC OUTCOME (PSOs)

B. E. AERONAUTICAL ENGINEERING (UG)

Academic Year 2019-2020

REGULATION-2016 (Revised) & 2019

SEMESTER-I														
19HE1101 & Technical English														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	2	-	1	2	1	2	3	1	3	3	2
CO2	1	2	1	1	1	2	1	1	1	3	1	2	2	3
CO3	1	2	1	1	1	2	1	1	2	3	1	2	2	2
C04	1	1	-	1	1	1	1	1	2	3	1	2	3	3
C05	-	1	1	1	1	1	1	2	2	3	1	2	2	2
AVG	1	1.4	1	1.2	1	1.4	1.2	1.2	1.8	3	1	2.2	2.4	2.4
19MA1102 & Calculus and linear algebra														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	3	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	3
C04	3	3	3	3	3	-	-	-	-	-	-	2	1	2
C05	3	3	3	3	3	-	-	-	-	-	-	2	2	1
AVG	3	3	3	2.6	2.8	-	-	-	-	-	-	2	1.8	2
19PH1151 & Applied Physics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	1	-	-	-	-	-	1	2	1
CO2	3	3	1	1	2	-	-	-	-	-	-	1	3	3
CO3	3	2	1	2	2	-	-	-	-	-	-	1	3	3
C04	3	2	3	2	3	1	-	-	-	-	-	1	2	2
C05	3	2	3	2	2	2	-	-	-	-	-	1	2	3
AVG	3	2.2	2	1.6	2	1.3	-	-	-	-	-	1	2.4	2.4
19CY1151 & Chemistry for Engineers														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	2	2	-	2	1	1	-	-	-	-	1	1	1
CO2	3	2	2	-	2	1	-	-	-	-	-	1	1	-
CO3	3	2	2	-	2	1	1	-	-	-	-	1	1	-
C04	3	2	2	2	2	1	-	-	-	-	-	1	1	1
C05	3	2	2	-	2	1	-	-	-	-	-	1	1	1
AVG	3	2	2	2	2	1	1	-	-	-	-	1	1	1
19CS1151 & Python Programming and Practices														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	-	2	-	-	-	-	-	-	2	2	2
CO2	2	3	3	-	2	-	-	-	2	-	-	2	2	2
CO3	2	3	3	-	2	-	-	-	2	-	-	2	2	2
C04	2	3	3	-	2	-	-	-	2	-	-	2	2	2
C05	2	3	3	-	2	-	-	-	2	-	-	2	2	2
AVG	2	3	3	-	2	-	-	-	2	-	-	2	2	2
19ME1152 & Engineering Drawing														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	1	-	1	-	-	1	1	1	1	2
CO2	3	3	2	1	1	-	1	-	-	1	1	1	1	2
CO3	3	3	3	-	1	1	1	-	-	1	1	-	1	1
C04	3	3	3	1	1	2	1	-	-	1	1	1	1	1
C05	3	3	3	1	1	3	1	-	-	1	1	1	1	1
AVG	2.8	3	2.6	1	1	2	1	-	-	1	1	1	1	1.4
19HE1071 & Value Added Course 1: Language Competency Enhancement Course-I														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	2	-	1	2	1	2	3	1	3	3	2
CO2	1	2	1	1	1	2	1	1	1	3	1	2	2	3
CO3	1	2	1	1	1	2	1	1	2	3	1	2	2	2
C04	1	1	-	1	1	1	1	1	2	3	1	2	3	3
C05	-	1	1	1	1	1	1	2	2	3	1	2	2	2
AVG	1	1.4	1	1.2	1	1.4	1.2	1.2	1.8	3	1	2.2	2.4	2.4
SEMESTER-II														
19HE2101 & Business English for Engineers														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1	1	1	2	1	2	2	3	-	3	1	-
CO2	2	1	1	1	1	2	2	2	2	3	-	2	-	1
CO3	2	2	1	1	1	2	2	2	2	3	1	3	1	-
C04	2	2	1	1	2	2	2	2	3	3	1	3	1	1
C05	1	1	1	1	1	2	2	1	2	3	1	3	1	1
AVG	1.6	1.6	1	1	1.2	2	1.8	1.8	2.2	3	1	2.8	1	1
19MA2101 & Differential equations and complex variables														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2

CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	2
C04	3	3	3	2	2	-	-	-	-	-	-	2	2	2
C05	3	3	3	3	3	-	-	-	-	-	-	2	2	2
AVG	3	3	3	2.4	2.4	-	-	-	-	-	-	2	2	2
19EE2103 & Basic of Electrical and Electronics Engineering														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO2	-	2	-	-	-	-	-	-	-	-	-	-	3	-
CO3	-	1	2	1	-	2	-	-	-	-	-	-	3	3
C04	-	-	-	-	-	-	-	-	1	-	1	-	3	-
C05	-	-	1	1	1	-	-	-	-	-	-	-	3	-
AVG	3	3	1.5	1	1	2	-	-	1	-	1	-	3	3
19ME2101 & Engineering Mechanics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	-	-	-	1	-	-	-	1	1	1	2
CO2	3	3	2	1	-	-	1	-	-	-	1	1	1	2
CO3	3	3	1	-	-	1	1	-	-	1	1	-	1	1
C04	3	3	2	1	-	2	1	-	-	1	1	1	1	1
C05	3	3	2	1	-	3	1	-	-	1	1	1	1	1
AVG	3	3	1.6	1	-	2	1	-	-	1	1	1	1	1.4
19PH2151 & Material Science														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	-	-	-	-	-	1	2	1
CO2	3	3	1	1	2	-	-	-	-	-	-	1	2	2
CO3	3	2	1	2	2	-	-	-	-	-	-	1	2	3
C04	3	3	1	2	2	1	-	-	-	-	-	1	2	2
C05	3	2	2	3	2	1	2	-	-	-	-	1	2	3
AVG	3	2.4	1.2	1.8	1.8	1	2	-	-	-	-	1	2	2.2
19CY2151 & Environmental Studies														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	2	3	3	2	-	-	2	-	-
CO2	2	-	-	-	-	2	3	3	2	-	-	2	-	-
CO3	2	1	1	-	-	2	3	3	2	-	-	2	-	-
C04	2	1	2	-	-	2	3	3	2	-	-	2	-	-
C05	2	1	2	-	-	2	3	3	2	-	-	2	-	-
AVG	2	1	1.7	-	-	1	2	3	2	-	-	2	-	-
19HE2071 & Language Competency Enhancement Course-II														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1	1	1	2	1	2	2	3	-	3	1	-
CO2	2	1	1	1	1	2	2	2	2	3	-	2	-	1
CO3	2	2	1	1	1	2	2	2	2	3	1	3	1	-

C04	2	2	1	1	2	2	2	2	3	3	1	3	1	1
C05	1	1	1	1	1	2	2	1	2	3	1	3	1	1
AVG	1.6	1.6	1	1	1.2	2	1.8	1.8	2.2	3	1	2.8	1	1
19ME2001 & Engineering Practices Laboratory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	3	-	3	-	1	-	1	-	-	-	1	2
CO2	3	-	3	-	3	-	1	-	1	-	-	-	1	2
CO3	3	-	3	-	3	-	1	-	1	-	-	-	1	2
AVG	3	-	3	-	3	-	-	-	1	-	-	-	1	2
SEMESTER-III														
16MA3103-Fourier Analysis and Statistics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	-	-	-	-	-	-	2	3	2
CO2	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO4	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO5	3	3	2	2	-	-	-	-	-	-	-	2	3	2
AVG	3	3	2	2	1	-	-	-	-	-	-	2	3	2
16AE3201-Aero Engineering Thermodynamics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	1	3	2
CO2	3	3	2	-	-	-	1	-	-	-	-	1	3	2
CO3	3	3	2	-	-	-	1	-	-	-	-	1	3	2
CO4	3	3	2	-	-	-	1	-	-	-	-	1	3	2
CO5	3	3	2	-	-	-	1	-	-	-	-	2	3	2
AVG	3	3	2	-	-	-	1	-	-	-	-	1.2	3	2
16AE3202-Solid Mechanics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	-	-	1	1	-	-	-	-	2	3	2
CO2	3	3	1	-	-	1	1	-	-	-	-	2	3	2
CO3	3	3	1	-	-	1	1	-	-	-	-	2	3	2
CO4	3	3	1	-	-	1	1	-	-	-	-	2	3	2
CO5	3	3	1	-	-	1	1	-	-	-	-	2	3	2
AVG	3	3	1	-	-	1	1	-	-	-	-	2	3	2
16AE3203-Engineering Fluid Mechanics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	3	-	-	-	-	-	-	-	-	-	2	3	1
CO2	3	2	-	-	-	-	-	-	-	-	-	2	3	1
CO3	3	3	2	2	-	-	-	-	-	-	-	2	3	1
CO4	3	3	2	3	-	-	-	-	-	-	-	2	2	2
CO5	3	3	2	3	-	-	-	-	-	-	-	2	2	2
AVG	3	2.8	2	2.667	-	-	-	-	-	-	-	2	2.6	1.4
16AE3204-Elements of Aeronautics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	1
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	1
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	1
CO4	3	-	-	-	-	-	-	-	-	-	-	-	2	1
CO5	3	-	-	-	-	-	-	-	-	-	-	-	2	1
AVG	3	-	-	-	-	-	-	-	-	-	-	-	2	1
16AE3205-Aircraft Systems and Instruments														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	-	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	-	2	-	-	-	-	-	-	-	-		3	2
CO4	3	-	2	-	-	-	2	-	-	-	-	3	3	2
CO5	3	2	2	-	2	-	-	-	-	-	-	-	3	2
AVG	3	2	2	-	2	-	2	-	-	-	-	3	3	2
16AE3001-Fluid mechanics and Thermodynamics Lab														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	-	-	-	-	2	-	-	1	3	2
CO2	3	3	3	3	-	-	-	-	2	-	-	2	3	2
CO3	3	3	3	2	-	-	-	-	2	-	-	1	3	2
CO4	3	3	3	2	-	-	-	-	2	-	-	2	3	2
CO5	3	3	3	2	-	-	2	-	2	-	-	1	3	2
AVG	3	3	2.8	2.4	-	-	2	-	2	-	-	1.4	3	2
16AE3002-Aircraft component Drawing Laboratory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	3	2	3	-	-	-	1	2	1	2	2	2
CO2	3	-	3	2	3	-	-	-	1	2	1	2	1	2
CO3	3	-	3	2	2	-	-	-	1	2	1	2	1	2

CO4	3	-	3	2	3	-	-	-	1	2	1	2	1	2
CO5	3	-	3	2	3	-	-	-	1	2	1	2	1	2
AVG	3	-	3	2	2.8	-	-	-	1	2	1	2	1.2	2
SEMESTER-IV														
16MA4107-Numerical Methods														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO2	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO4	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO5	3	3	2	2	-	-	-	-	-	-	-	2	3	2
AVG	3	3	2	2	-	-	-	-	-	-	-	2	3	2
16AE4201-Aerodynamics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	1	3	2
CO2	3	2	2	2	-	-	-	-	-	-	-	1	3	2
CO3	3	2	2	2	2	-	-	-	-	-	-	2	3	2
CO4	3	2	2	2	2	-	-	-	-	-	-	2	3	2
CO5	2	2	-	-	-	-	-	-	-	-	-	1	2	1
AVG	2.8	2	2	2	2	-	-	-	-	-	-	1.4	2.8	1.8
16AE4202-Mechanics of Machines														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO2	3	2	1	-	1	-	-	-	-	-	-	-	2	1
CO3	3	2	-	1	-	-	-	-	-	-	-	-	2	1
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	1
CO5	3	2	-	1	-	-	-	-	-	-	-	-	2	2
AVG	3	2	1	1	1	-	-	-	-	-	-	-	2.2	1.4
16AE4203-Gas Turbine Propulsion														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2	-	-	-	-	-	-	-	-	3	-
CO2	3	2	1	2	-	-	-	-	-	-	-	-	3	-
CO3	3	2	1	2	-	-	1	-	-	-	-	2	3	2
CO4	3	2	1	3	-	-	-	-	-	-	-	-	3	2
CO5	3	2	2	3	-	-	-	-	-	-	-	2	3	2

AVG	3	2	1.25	2.4	-	-	1	-	-	-	-	2	3	2
16AE4204-Aircraft Strength of Materials														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	2	3	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2	3	2
CO3	3	2	1	-	-	-	-	-	-	-	-	2	3	2
CO4	3	2	1	-	-	-	-	-	-	-	-	2	3	2
CO5	3	2	1	-	-	-	-	-	-	-	-	2	3	2
AVG	3	2	1	-	-	-	-	-	-	-	-	2	3	2
16EI4231-Control Engineering														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	3	2	3	-	-	-	-	-	-	1	2	1
CO2	3	-	3	2	3	-	-	-	-	-	-	1	-	1
CO3	3	3	3	2	3	-	-	-	-	-	-	1	2	1
CO4	3	3	3	2	3	-	-	-	-	-	-	1	2	1
CO5	3	3	3	2	3	-	-	-	-	-	-	1	2	2
AVG	3	3	3	2	3	-	-	-	-	-	-	1	2	1.2
16AE4001-Aerodynamics Laboratory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	2	2	-	-	3	1
CO2	3	2	2	2	2	-	-	-	2	2	1	2	3	2
CO3	3	2	2	2	2	-	-	-	2	2	1	2	3	2
CO4	3	2	2	2	2	-	-	-	2	2	1	2	3	2
CO5	3	-	-	-	-	-	-	-	2	2	-	2	3	2
AVG	3	2	2	2	2	-	-	-	2	2	1	2	3	1.8
16AE4002-Aircraft Strength of Materials Laboratory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	1	-	-	2	-	-	1	2	3
CO2	3	2	1	-	-	1	-	-	2	-	-	1	2	3
CO3	3	2	1	-	-	1	-	-	2	-	-	2	2	3
CO4	3	2	1	-	-	1	-	-	2	-	-	1	2	3
CO5	3	2	1	-	-	1	-	-	2	-	-	1	2	3
AVG	3	2	1	-	-	1	-	-	2	-	-	1.2	2	3
SEMESTER-V														
16AE5201-Aircraft Performance														

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	2	3	1
CO2	3	2	2	-	-	1	-	-	1	-	1	2	3	2
CO3	3	2	1	2	-	-	-	-	1	-	1	2	3	2
CO4	3	2	1	2	-	2	1	-	1	-	1	2	3	2
CO5	3	2	2	2	-	2	1	-	1	-	1	2	2	2
AVG	3	1.8	1.5	2	-	1.67	1	-	1	-	1	2	2.8	1.8
16AE5202-High Speed Aerodynamics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	3	2	2	2	-	-	-	-	-	-	-	3	1
CO3	3	3	-	2	2	-	-	-	-	-	-	-	3	1
CO4	3	3	3	2	2	-	-	-	-	-	-	-	3	-
CO5	3	-	2	-	2	-	-	-	-	1	-	2	3	3
AVG	3	3	2.33	2	2	-	-	-	-	1	-	2	3	1.5
16AE5203-Aircraft Structures														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	2	-	-	-	-	-	-	2	3	2
CO2	3	3	2	-	2	-	-	-	-	-	-	2	3	2
CO3	3	3	2	-	2	-	-	-	-	-	-	2	3	2
CO4	3	3	2	-	2	-	-	-	-	-	-	2	3	2
CO5	3	3	2	-	2	2	-	-	-	-	-	2	3	2
AVG	3	3	2	-	2	2	-	-	-	-	-	2	3	2
16AE5204-Advanced Propulsion														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO2	3	3	3	2	-	-	-	-	-	-	-	2	3	2
CO3	3	3	2	2	-	-	2	-	-	-	-	2	3	2
CO4	3	3	2	2	-	-	2	-	-	-	-	2	3	2
CO5	3	-	-	-	-	-	2	-	-	-	-	2	3	2
AVG	3	3	2.25	2	-	-	2	-	-	-	-	2	3	2
16AE5205-Aircraft General Engineering Maintenance and practice														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	-	-	-	-	-	2	2	3	3
CO2	3	3	2	3	3	-	-	-	-	-	2	2	3	3
CO3	2	3	2	-	3	-	-	-	-	-	2	2	3	2
CO4	2	2	2	3	3	-	-	-	-	-	2	3	3	3
CO5	2	2	2	-	3	-	-	-	-	-	2	3	3	2
AVG	2.4	2.4	2	2.67	3	-	-	-	-	-	2	2.4	3	2.6
16AE5001-Aircraft Structures Laboratory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	-	-	-	-	2	-	-	2	3	3

CO2	3	-	2	-	-	-	-	-	2	-	-	2	3	3
CO3	3	-	2	-	2	-	-	-	2	-	-	2	3	3
CO4	3	-	2	-	-	-	-	-	2	-	-	2	3	3
CO5	3	-	2	-	-	-	-	-	2	-	-	2	3	3
AVG	3	-	2	-	2	-	-	-	2	-	-	2	3	3
16AE5002-Propulsion Laboratory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	2	-	2	3	2
CO2	3	3	-	2	2	-	-	-	-	2	-	2	3	3
CO3	3	3	-	2	-	-	-	-	-	2	-	2	3	3
CO4	3	2	-		-	-	-	-	-	2	-	2	3	3
CO5	3	3	-	2	-	-	-	-	-	2	-	2	3	3
AVG	3	2.75	-	2	2	-	-	-	-	2	-	2	3	2.8
SEMESTER-VI														
16AE6201-Aircraft stability and control														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	-	-	-	-	-	1	-	1	2	1
CO2	3	2	2	2	-	1	1	-	-	1	-	2	3	2
CO3	3	2	2	2	-	1	1	-	-	1	-	2	3	2
CO4	3	2	2	2	-	1	1	-	-	1	-	2	3	2
CO5	3	3	2	2	-	1	1	1	-	1	-	2	3	2
AVG	2.8	2	1.8	1.8	-	1	1	1	-	1	-	1.8	2.8	1.8
16AE6202-Finite Element Methods in Engineering														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	1	-	-	-	-	1	-	-	1	2	3
CO2	2	2	2	3	1	-	1	-	-	-	-	2	1	3
CO3	3	1	1	2	2	1	2	-	-	-	-	2	2	3
CO4	1	2	3	2	-	-	-	-	-	-	-	1	2	1
CO5	1	1	2	3	-	-	1	-	-	-	-	2	1	2
AVG	2	1.6	2	2.2	1.5	1	1.33	-	1	-	-	1.6	1.6	2.4
16AE6203-Composite Materials and Structures														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	-	-	-	-	-	-	-	1	3	2
CO2	3	2	2	2	-	-	-	-	-	-	-	1	3	2
CO3	3	2	2	2	-	-	-	-	-	-	-	1	3	2
CO4	3		2	2	2	-	-	-	-	-	-	1	1	1
CO5	3	2	2	2	-	-	-	-	-	-	-	1	3	2
AVG	3	2	2	2	2	-	-	-	-	-	-	1	2.6	1.8
16AE6001-Aircraft Design Project														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	2	3	2	2	2	3	3
CO2	3	3	3	3	2	-	1	1	3	2	2	2	3	3

CO3	3	3	3	3	3	1	-	1	3	2	2	2	3	3
CO4	3	3	3	3	2	-	2	1	3	2	2	2	3	3
CO5	3	2	3	3	3	2	-	2	3	2	2	2	3	3
AVG	3	2.8	3	3	2.6	1.33	1.33	1.4	3	2	2	2	3	3
16AE6002-Computer Aided Simulation Laboratory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	-	-	-	-	-	-	-	-	-	1	1
CO2	2	2	2	2	2	-	-	-	-	-	-	-	2	2
CO3	3	2	3	3	3	-	-	-	-	-	-	2	3	3
CO4	3	2	3	3	3	-	-	-	-	-	-	-	3	3
CO5	3	3	3	3	3	-	1	-	-	-	1	2	3	3
AVG	2.4	2.2	2.6	2.75	2.75	-	1	-	-	-	1	2	2.4	2.4
16AE6003-Aircraft Systems Laboratory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	-	3	-	-	2	2	-	2	3	1
CO2	3	2	2	2	-	-	-	-	2	2	-	-	3	2
CO3	3	3	3	2	-	-	-	-	2	2	-	-	3	3
CO4	3	2	2	3	-	2	-	-	2	3	-	2	3	1
CO5	3	2	2	3	-	3	-	-	2	2	-	2	3	2
AVG	3	2.2	2.2	2.6	-	2.67	-	-	2	2.2	-	2	3	1.8
16AE6801-Mini Project														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO2	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO3	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO4	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO5	3	3	3	3	3	2	2	3	3	3	3	2	3	3
AVG	3	3	3	3	3	2	2	3	3	3	3	2	3	3
SEMESTER-VII														
16AE7201-Avionics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	3	2	2	-	-	-	1	3	3	2
CO2	3	1	3	3	3	1	-	-	-	-	-	-	3	2
CO3	3	2	3	3	3	1	-	-	-	-	-	3	3	3
CO4	3	3	3	-	3	3	2	-	-	-	-	2	3	2
CO5	3	3	1	2	3	-	-	-	-	-	-	3	3	2
AVG	3.00	2.20	2.40	2.67	3.00	1.75	2.00	-	-	-	1.00	2.75	3.00	2.20
16AE7202-Computational Fluid Dynamics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	-	-	-	-	-	-	2	3	2
CO2	3	2	3	2	3	-	-	-	-	-	-	2	3	2
CO3	3	2	3	2	3	-	-	-	-	-	-	2	3	2

CO4	3	2	3	2	3	-	-	-	-	-	-	2	3	2
CO5	3	2	3	2	3	-	-	-	-	-	-	2	3	2
AVG	3	2	3	2	3	-	-	-	-	-	-	2	3	2
16AE7001-Aero Engine and Airframe Laboratory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	3	-	-	-	2	1	-	2	3	2
CO2	3	-	3	-	2	-	-	-	3	1	-	2	3	3
CO3	3	2	2	-	2	-	3	-	3	1	-	2	3	3
CO4	3	2	3	-	3	-	2	-	2	1	-	2	2	3
CO5	3	3	3	-	3	-	2	-	2	1	-	2	2	2
AVG	3.00	2.33	2.60	-	2.60	-	2.33	-	2.40	1.00	-	2.00	2.60	2.60
16AE7002-Avionics Laboratory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	1	-	-	-	3	3
CO2	3	3	-	-	-	-	-	-	1	-	-	-	2	3
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO4	3	3	3	-	2	-	-	-	-	-	2	1	2	3
CO5	3	3	3	-	2	-	-	-	-	-	2	1	3	3
AVG	3	3	3	-	2	-	-	-	1	-	2	1	2.6	3
16AE7701-Internship / Industrial Training														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO2	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO3	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO4	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO5	3	3	3	3	3	2	2	3	3	3	3	2	3	3
AVG	3	3	3	3	3	2	2	3	3	3	3	2	3	3
16AE7702-Technical Publication														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO2	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO3	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO4	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO5	3	3	3	3	3	2	2	3	3	3	3	2	3	3
AVG	3	3	3	3	3	2	2	3	3	3	3	2	3	3
SEMESTER-VIII														
16AE8901-Project work														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO2	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO3	3	3	3	3	3	2	2	3	3	3	3	2	3	3
CO4	3	3	3	3	3	2	2	3	3	3	3	2	3	3

CO5	3	3	3	3	3	2	2	3	3	3	3	2	3	3
AVG	3	3	3	3	3	2	2	3	3	3	3	2	3	3

PROFESSIONAL ELECTIVES

16AE5301-Aircraft materials and processes														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	3	-	-	-	-	-	-	-	-	3	3
CO2	3	-	-	3	-	-	-	-	-	-	-	-	3	3
CO3	3	-	-	3	-	3	-	-	-	-	-	-	3	3
CO4	3	-	-	3	-	-	-	-	-	-	-	-	3	3
CO5	3	-	-	3	-	-	-	-	-	-	-	-	3	3
AVG	3	-	-	3	-	3	-	-	-	-	-	-	3	3
16AE5302- Heat Transfer														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	-	-	2	-	-	-	-	2	3	1
CO2	3	3	2	3	-	-	2	-	-	-	-	2	3	1
CO3	3	3	2	3	-	-	2	-	-	-	-	2	3	1
CO4	3	3	2	3	-	-	2	-	-	-	-	2	3	1
CO5	3	3	2	3	-	-	2	-	-	-	-	2	3	1
AVG	3	3	2	3	-	-	2	-	-	-	-	2	3	1
16AE5303-Boundary layer Theory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2.2	1.2	1	-	-	-	-	-	-	-	-	3	2.2
CO2	3	3	2	2	2	-	-	-	-	1	-	2	-	3
CO3	3	3	1	2	1	-	-	-	-	1	-	2	-	3
C04	3	2	2	1	2	1	1	-	-	-	1	1	2	2
C05	3	2	1	-	1	-	-	2	-	-	1	1	2	1
AVG	3	3	2	1	2	1	-	2	1	1	2	2	2	2
16AE5304-Principles of Management														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	3	-	3	-	-	-
CO2	2	-	-	-	-	-	-	3	3	-	3	-	-	-
CO3	2	-	-	-	-	-	-	-	3	-	3	-	-	-
C04	2	-	-	-	-	-	-	-	3	-	3	-	-	-
C05	2	-	-	-	-	-	2	-	3	-	3	-	-	-
AVG	2	-	-	-	-	-	2	3	3	-	3	-	-	-
16AE6301 -Theory of Elasticity														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	3	3	2	-	-	-	-	-	-	-	-	3	2
CO3	3	3	3	2	-	-	-	-	-	-	-	-	3	2

CO4	3	3	3	2	-	-	-	-	-	-	-	-	3	2
CO5	3	3	3	2	-	-	-	-	-	-	-	-	3	2
AVG	3	2.8	2.8	2	-	-	-	-	-	-	-	-	3	2
16AE6302- Introduction to Cryogenics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	3	2
CO2	3	2	1	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	2	1	-	-	-	-	-	-	-	-	3	3
C04	3	2	1	-	-	-	-	-	-	-	-	-	3	2
C05	3	2	1	-	-	-	-	-	-	-	-	-	3	2
AVG	3	2.2	1.2	1	-	-	-	-	-	-	-	-	3	2.2
16AE6303 - Wind Tunnel Techniques														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	-	-	3	-	3	3
CO2	3	3	3	3	-	-	-	-	-	-	3	-	3	3
CO3	3	3	3	3	-	-	-	-	-	-	3	-	3	3
CO4	3	3	1	3	-	-	-	-	-	-	1	-	3	2
CO5	3	3	1	2	-	-	-	-	-	-	1	-	3	2
AVG	3	3	2.2	2.8	-	-	-	-	-	-	2.2	-	3	2.6
16AE6304 - Aero Engine Maintenance and Repair														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	-	-	-	-	-	2	1	-	3	3	1
CO2	3	3	1	3	2	-	-	-	2	-	-	-	3	2
CO3	3	1	1	-	-	-	-	-	-	-	-	-	3	1
CO4	3	3	2	1	-	-	-	-	-	1	-	-	3	1
CO5	3	1	1	2	-	-	-	-	2	-	-	-	3	2
AVG	3	1.8	1.4	2	2	-	-	-	2	1	-	3	3	1.4
16AE7301-Vibration and Elements of Aero Elasticity														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	2	-	-	-	-	-	-	-	-	-	3	2
C04	3	3	2	-	-	-	-	-	-	-	-	-	3	2
C05	2	2	2	-	-	-	-	-	-	-	-	-	2	2
AVG	2.8	2.8	2	-	-	-	-	-	-	-	-	-	2.8	2
16AE7302-Satellite Propulsion														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	-	-	-	-	-	-	-	3	1
CO2	3	2	1	1	1	-	-	-	-	-	-	-	3	1
CO3	3	2	2	1	-	-	-	-	-	-	-	-	3	1
C04	3	2	1	-	-	-	-	-	-	-	-	-	3	2
C05	3	2	1	-	-	-	-	-	-	-	-	-	3	1

AVG	3	1	1	1	1	-	-	-	-	-	-	-	3	1
16AE7303-Rockets and Missiles														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	3	-	-	-	2	1	-	2	3	2
CO2	3	-	3	-	2	-	-	-	3	1	-	2	3	3
CO3	3	2	2	-	2	-	3	-	3	1	-	2	3	3
C04	3	2	3	-	3	-	2	-	2	1	-	2	2	3
C05	3	3	3	-	3	-	2	-	2	1	-	2	2	2
AVG	3	2.3	2.6	-	2.6	-	2.3	-	2.4	1	-	2	2.6	2.6
16AE7304-Airframe Maintenance and Repair														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	3	3	3
CO2	3	1	3	-	2	-	1	2	2	-	2	2	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	2
C04	3	3	3	3	3	-	-	-	-	-	-	2	3	3
C05	2	3	3	3	2	3	-	-	-	-	-	3	3	2
AVG	2.8	2.5	3	3	2.5	3	1	2	2	-	2	2.4	3	2.6
16AE7305-Experimental Stress analysis														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	3	3	3
CO2	3	1	3		2	-	1	2	2		2	2	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	2
C04	3	3	3	3	3	-	-	-	-	-	-	2	3	3
C05	2	3	3	3	2	3	-	-	-	-	-	3	3	2
AVG	2.8	2.5	3	3	2.5	3	1	2	2	-	2	2.4	3	2.6
16AE7306-Helicopter Theory														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	-	-	-	-	-	-	-	-	3	1
CO2	3	-	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	-	2	-	-	-	-	-	-	-	-	2	3	1
C04	3	-	3	2	-	-	-	-	-	-	-	-	3	2
C05	3	-	3	2	3	2	-	-	-	-	-	3	3	3
AVG	3	-	2.4	2	3	2	-	-	-	-	-	2.5	3	1.8
16AE7307-Aircraft Design														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	2	3	2	2	2	3	3
CO2	3	3	3	3	2	-	1	1	3	2	2	2	3	3
CO3	3	3	3	3	3	1	-	1	3	2	2	2	3	3
C04	3	3	3	3	2	-	2	1	3	2	2	2	3	3
C05	3	2	3	3	3	2	-	2	3	2	2	2	3	3
AVG	3	2.8	3	3	2.6	1.3	1.3	1.4	3	2	2	2	3	3
16AE7308-Engine system and control														

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	-	-	-	-	-	-	-	3	3
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	2	1	-	-	-	-	-	-	-	-	-	3	2
C04	2	3	2	-	-	-	-	-	-	-	-	-	3	2
C05	2	3	2	-	-	-	-	-	-	-	-	-	3	2
AVG	2.6	2.4	1.6	-	-	-	-	-	-	-	-	-	3	2.2
16AE8301-Fatigue and Fracture														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.00	2.00	2.00	3.00	-	-	-	-	-	-	-	2.00	3.00	1.00
CO2	3.00	2.00	3.00	2.00	-	-	-	-	-	-	-	2.00	3.00	2.00
CO3	3.00	2.00	3.00	3.00	2.00	-	-	-	-	-	-	2.00	2.00	3.00
C04	3.00	2.00	3.00	3.00	3.00	-	-	-	-	-	-	2.00	3.00	2.00
C05	3.00	2.00	3.00	3.00	2.00	-	-	-	-	-	-	2.00	3.00	2.00
AVG	3.00	2.00	2.80	2.80	2.33	-	-	-	-	-	-	2.0	2.80	2.00
16AE8302-Professional Ethics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	3	-	3	-	-	-	-	1	-
CO2	2	-	-	-	-	3	-	3	-	-	-	-	1	-
CO3	3	-	-	-	-	3	-	3	-	2	2	-	1	-
C04	2	-	-	-	-	2	-	3	2	-	2	-	1	-
C05	2	-	-	-	-	2	-	3	-	-	-	-	1	-
AVG	2.2	-	-	-	-	2.6	-	3	2	2	2	-	1	-
16AE8303-Space Mechanics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	-	-	-	-	-	-	-	-	3	2
CO2	3	3	2	1	-	-	-	-	-	-	-	-	3	2
CO3	3	3	2	1	-	-	-	-	-	-	-	-	3	2
C04	3	3	2	1	-	-	-	-	-	-	-	-	3	2
C05	3	3	2	1	-	-	-	-	-	-	-	-	3	2
AVG	3	3	2	1	-	-	-	-	-	-	-	-	3	2
16AE8304-Aviation Management and Air safety														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	-	-	-	-	-	-	-	-	3	1
CO2	3	1	1	-	-	-	-	-	-	-	-	-	3	1
CO3	3	2	1	-	-	-	-	-	-	-	-	-	3	1
C04	3	1	1	-	-	-	-	-	-	-	-	-	3	1
C05	2	1	1	-	-	-	-	-	-	-	-	-	3	1
AVG	2.6	1.2	1	-	-	-	-	-	-	-	-	-	3	1
16AE8305-Structural Dynamics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	-	3	2

CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	2	-	-	-	-	-	-	-	-	-	3	2
C04	3	3	2	-	-	-	-	-	-	-	-	-	3	2
C05	2	2	2	-	-	-	-	-	-	-	-	-	2	2
AVG	2.8	2.8	2	-	-	-	-	-	-	-	-	-	2.8	2
16AE8306-UAV Systems														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	2	-	-	-	3	-	2	3	-
CO2	3	3	3	2	-		-	-	-	-	-	3	3	-
CO3	3	2	3	2	-	3	3	-	-	-	-	3	3	2
C04	2	2	2	-	-	3	3	-	-	-	-	2	3	2
C05	2	2	2	2	3	2	-	2	-	3	-	3	3	2
AVG	2.4	2.25	2.5	2	3	2.5	3	2	-	3	-	2.6	3	2
16AE8307-Experimental Aerodynamics														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	2	-	-	-	-	-	-	-	-	-	3	2
C04	3	3	2	-	-	-	-	-	-	-	-	-	3	2
C05	2	2	2	-	-	-	-	-	-	-	-	-	2	2
AVG	2.8	2.8	2	-	-	-	-	-	-	-	-	-	2.8	2
16AE8308-Air Traffic Control and Planning														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	-	-
C04	3	2	2	-	-	-	-	-	-	-	-	-	-	-
C05	3	2	2	-	-	-	-	-	-	-	-	-	-	-
AVG	3	2	2	-	-	-	-	-	-	-	-	-	-	-

OPEN ELECTIVES

16AE6401-Introduction to Flight														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
C04	3	-	-	-	-	-	-	-	-	-	-	-	2	-
C05	3	-	-	-	-	-	-	-	-	-	-	-	2	-
AVG	2.6	-	-	-	-	-	-	-	-	-	-	-	1.8	-
16AE7402-Aerodynamics for Industrial Applications														

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	2	-	-	-	-	-	-	-	-	-	3	2
C04	3	3	2	-	-	-	-	-	-	-	-	-	3	2
C05	2	2	2	-	-	-	-	-	-	-	-	-	2	2
AVG	2.8	2.8	2	-	-	-	-	-	-	-	-	-	2.8	2
16AE7403-Introduction to Drones														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	-	-	-	-	-	-	-	1	2	2
CO2	3	2	2	2	1	-	-	-	-	-	-	1	2	2
CO3	3	2	2	2	1	-	-	-	-	-	-	1	2	2
C04	3	3	2	2	2	-	-	-	-	-	-	3	2	2
C05	2	2	1	2	-	-	-	-	-	-	-	3	1	2
AVG	2.8	2.2	1.8	2	1.3	-	-	-	-	-	-	1.8	1.8	2

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