Bharath
INSTITUTE OF HIGHER EDUCATION AND RESEARCH
(Declared as deemed to be university under section 3 of UGC Act 1956, vide notification No.F.9-5/2000-U.3)

FACULTY OF ENGINEERING AND TECHNOLOGY

REGULATIONS 2015

B. TECH – AERONAUTICAL ENGINEERING

(FULL TIME)

CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM

(I-VIII SEMESTERS)

DEPARTMENT OF AERONAUTICAL ENGINEERING

BHARATH INSTITUTE OF SCIENCE AND TECHNOLOGY

NO: 173, AGARAM ROAD, SELAIYUR,

CHENNAI -600 073, TAMIL NADU

B.TECH - AERONAUTICAL ENGINEERING

CURRICULUM AND SYLLABUS

CHOICE BASED CREDIT SYSTEM

I – VIII SEMESTERS

SEMESTER I						
Code No.	**Category**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
BEN101	HS	English-I	3	1	0	3
BMA101	BS	Mathematics –I	3	1	0	3
BPH 101	BS	Engineering Physics – I	3	0	0	3
BCH101	BS	Engineering Chemistry – I	3	0	0	3
BCS101	ES	Fundamentals of Computing and Programming	3	0	0	3
BSS101	HS	Personality Development	2	1	0	2
BBT 102	BS	Biology for Engineers	2	0	0	2
BCE101	ES	Basic Civil Engineering	2	0	0	2
BME101	ES	Engineering Graphics-E	2	3	0	4
PRACTICAL						
BCM1L1	ES	Basic Civil and Mechanical Engineering Practices Laboratory	0	0	3	1
BSS1L4/ 1L5/IL6	HS	NCC/NSS/NSO to be conducted during week ends				1
E- Civil, Mechanical, Aeronautical Branches						
Total No. of Contact Hours: 35			**Total No. of Credits: 27**			

** Engineering graphics – Final examination will be evaluated by internal faculty.

* Laboratory classes on alternate weeks. The lab examinations will be held only in the second semester (including the first semester experiments also).

SEMESTER II						
Code No.	**Category**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
BEN 201	HS	English-II	3	1	0	3
BMA201	BS	Mathematics- II	3	1	0	3
BPH 201	BS	Engineering Physics – II	3	0	0	3
BCH201	BS	Engineering Chemistry – II	3	0	0	3
	HS	Foreign/Indian Language	3	0	0	3
BME202	ES	Engineering Mechanics	3	1	0	3
BEE201	ES	Basic Electrical and Electronics Engineering	2	0	0	2
PRACTICAL						
BCS2L2	ES	Computer Practices Lab	0	0	3	1
BEE2L1	ES	Basic Electrical and Electronics Engineering Practices	0	0	3	1
BPC2L1*	BS	Physics and Chemistry Laboratory	0	0	3/3	1
BSS2L7	HS	Yoga to be conducted during week ends				1
# Any one of the following courses: BFR201 – French, BGM201 – German, BJP201- Japanese, BKR201 – Korean, BCN201 – Chinese, BTM201 – Tamil						
*Laboratory Classes on alternate weeks for Physics and Chemistry. The lab examinations will be held only in the second semester (including the first semester experiments also)						
Total No. of Contact Hours: 35			**Total No. of Credits: 24**			

SEMESTER III						
Code No.	**Category**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
BMA301	BS	Mathematics – III	3	2	0	4
BAN301	PC	Fundamentals of Aeronautics and Astronautics	3	0	0	3
BAN302	PC	Fundamentals of Fluid Mechanics	4	0	0	4

BAN303	PC	Fundamentals of Aero - Thermodynamics	4	0	0	4
BAN304	PC	Fundamentals of Structural Mechanics	4	0	0	4
BAN305	PC	Mechanics of Machines	3	0	0	3
PRACTICALS						
BAN3L1	PC	Fluid Mechanics and Machineries Laboratory	0	0	3	2
BAN3L2	PC	Strength of Materials Laboratory	0	0	3	2
BME3L1	PC	Machine Drawing	0	0	3	2
Total No. of Contact Hours: 32					**Total No. of Credits: 28**	

SEMESTER IV						
Code No.	**Category**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
BMA402	BS	Numerical Methods	3	2	0	4
BAN401	PC	Aircraft Structures – I	4	0	0	4
BAN402	PC	Aerodynamics – I	4	0	0	4
BAN403	PC	Aircraft Propulsion	4	0	0	4
BAN404	PC	Aircraft Systems and Instrumentation	3	0	0	3
BCE407	HS	Environmental Studies	3	0	0	3
PRACTICALS						
BAN4L1	PC	Aircraft Structures Laboratory	0	0	3	2
BAN4L2	PC	Manufacturing Engineering Laboratory	0	0	2	1
BAN4S1	PR	Computer Aided Design and Drafting	0	0	2	1
Total No. of Contact Hours: 30					**Total No. of Credits: 26**	

SEMESTER V						
Code No.	**Category**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
BAN501	PC	Aircraft Structures – II	4	0	0	4
BAN502	PC	Aerodynamics – II	4	0	0	4
BAN503	PC	Advanced Aerospace Propulsion	4	0	0	4
BAN504	PC	Flight mechanics	4	0	0	4
BAN505	ES	Manufacturing Engineering	3	0	0	3

-	CE	Core Elective – I	3	0	0	3
PRACTICALS						
BAN5L1	PC	Aerodynamics Laboratory	0	0	3	2
BAN5L2	PC	Aero Design and Modeling Laboratory	0	0	2	1
BAN5S2	PR	Computer Aided Analysis Laboratory	0	0	2	1
BAN5C1	PR	Comprehension - I	0	0	0	1
Total No. of Contact Hours: 29					**Total No. of Credits: 27**	

SEMESTER VI						
Code No.	**Category**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
BSS601	HS	Value Education and professional Ethics	3	0	0	3
BAN601	PC	Aerospace Structural Materials and Composites	3	0	0	3
BAN602	PC	Finite Element Methods	4	0	0	4
BAN603	PC	Control Engineering	3	0	0	3
-	CE	Core Elective – II	3	0	0	3
-	NE	Non – Major Elective – I	3	0	0	3
PRACTICALS						
BAN6V1	PR	Value Added Program – II	0	0	2	1
BAN6L1	PC	Aircraft System Laboratory	0	0	3	2
BAN6L2	PC	Propulsion Laboratory	0	0	3	2
BAN6L3	PC	Aircraft Design Project – I	0	0	4	2
Total No. of Contact Hours: 31					**Total No. of Credits: 26**	

SEMESTER VII						
Code No.	**Category**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
BAN701	PC	Computational Fluid Dynamics	3	0	0	3
BAN702	PC	Avionics	3	0	0	3
BAN703	PC	Heat Transfer	3	0	0	3
-	CE	Core Elective – III	3	0	0	3

-	NE	Non – Major Elective – II	3	0	0	3
-	OE	Open Elective – I	3	0	0	3
PRACTICALS						
BAN7L1	PC	Airframe and Aero Engine Repair Lab	0	0	2	1
BAN7L2	PC	Avionics Laboratory	0	0	2	1
BAN7L3	PC	Aircraft Design Project – II	0	0	4	2
BAN7P1	PR	Term Paper	0	0	4	2
Total No. of Contact Hours: 30					**Total No. of Credits: 24**	

SEMESTER VIII						
Code No.	**Category**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
-	NE	Non – Major Elective – III	3	0	0	3
-	OE	Open Elective – II	3	0	0	3
PRACTICALS						
BAN8C2	PR	Comprehension – II	0	0	0	1
BAN8P1	PR	Project Work	0	0	18	9
Total No. of Contact Hours: 24					**Total No. of Credits: 16**	

OVERALL CREDITS FOR THE PROGRAMME : 198

LIST OF ELECTIVES

List of Core Elective(CE) I:

Code No.	Course Title	L	T	P	C
BANE01	Basics of Aircraft Maintenance and Repair#	3	0	0	3
BANE02	Rockets and Missiles*	3	0	0	3
BANE03	Experimental Stress Analysis$	3	0	0	3
BANE04	Experimental Aerodynamics+	3	0	0	3

List of Core Elective (CE)II:

Code No.	Course Title	L	T	P	C
BANE05	Helicopter Maintenance#	3	0	0	3
BANE06	Space Mechanics*	3	0	0	3
BANE07	Theory of Vibrations$	3	0	0	3
BANE08	Helicopter Aerodynamics+	3	0	0	3

List of Core Elective (CE) III:

Code No.	Course Title	L	T	P	C
BANE09	Aircraft Engine Repair and Maintenance#	3	0	0	3
BANE10	Cryogenic Rocket Propulsion*	3	0	0	3
BANE11	Theory of Plates and Shells$	3	0	0	3
BANE12	Hypersonic Aerodynamics+	3	0	0	3

 # - Specialization in Maintenance
*** - Specialization in Propulsion**
$- Specialization in Structures
+ - Specialization in Aerodynamics

List of Non Major Elective (NE) I:

Code No.	Course Title	L	T	P	C
BANE13	An Introduction to Combustion	3	0	0	3
BANE14	Principles of Turbo machinery in Air breathing Engines	3	0	0	3
BANE15	Nano Science and Technology	3	0	0	3
BANE16	Unmanned Aerial Vehicle	3	0	0	3

List of Non Major Elective (NE) II:

Code No.	Course Title	L	T	P	C
BANE17	Boundary Layer Theory	3	0	0	3
BANE18	Fatigue and Fracture Mechanics	3	0	0	3
BANE19	High Temperature Materials	3	0	0	3

List of Non Major Elective (NE) III:

Code No.	Course Title	L	T	P	C
BANE20	Wind Energy	3	0	0	3
BANE21	Satellite Technology	3	0	0	3
BANE22	Aircraft Rules and Regulations CAR I and II	3	0	0	3

List of Open Elective (OE) I:

Code No.	Course Title	L	T	P	C
BBA001	Principles of Management and Organizational Behavior	3	0	0	3
BANE23	Airport Management	3	0	0	3
BANE24	Aerospace Bio – Medical and Life Support Engineering	3	0	0	3

List of Open Elective (OE) II:

Code No.	Course Title	L	T	P	C

BBA008	Total Quality Management	3	0	0	3
BANE25	Industrial Aerodynamics	3	0	0	3
BANE26	Mechanics of Heterogeneous Materials	3	0	0	3
BBA007	Engineering Economics and Cost Analysis	3	0	0	3

BEN101	**ENGLISH - I**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	3	1	0	3
	Prerequisite – +2 Level English				
	Course Designed by – Dept of English				

OBJECTIVES

To make the students learn the basic modes of communication for fluency and attainment of confidence in speech, reading and writing.

COURSE OUTCOMES (COs)

CO1	Understand the importance of being responsible, logical, and thorough.
CO2	Respond to the situations where short reports and instructions are required.
CO3	Explain "how things work", and what to suggest when "things don't work
CO4	Develop our confidence and authority in the practical use of language.
CO5	Understand the importance of being responsible, logical, and thorough.
CO6	e to Face interviews and competitive examinations

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	C	d	e	f	g	h	i	j	k	l
2	CO1	H	H	H	H	H	M	L	L	H	H	H	H
	CO2							L					
	CO3	H						H		H			H
	CO4	H	M				M	L	H	H			H
	CO5							L					
	CO6	H		H	H	H	H	L		H	H	M	H

3	Category	Humanities & Social Studies (HS)	Basic Sciences &Maths (BS)	Engg Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non-Major Elective (NE)	Open Elective (OE)	Project/ Term Paper/ Seminar/ Internship (PR)
		√							
4	Approval	37th Meeting of Academic Council, May 2015							

UNIT I STRUCTURES 12

Parts of speech - Active and passive voices - Subject verb agreement. - Writing about School life, Hobbies, Family and friends – Word formation with prefixes and suffixes - Tenses - Concord - Summarizing - Note-making

UNIT II TRANSCODING 12

Cause and effect relations – Punctuations –Differences between verbal and nonverbal communication -E - mail communication – Homophones - Etiquettes of E mail communication. Interpreting graphic representation - Flow chart and Bar chart.

UNIT III REPORTING 12

Degrees of comparison – Positive, Comparative, Superlative - questions- SI units -Lab reports - Physics chemistry, workshop and Survey report for introducing new product in the market.

UNIT IV FORMAL DOCUMENTATION 12

Writing project proposals - Presentation skills - Prefixes and suffixes - If conditions - Writing a review-Preparing minutes of the meeting, Agenda, official circulars.

UNIT V METHODOLOGY 12

Accident reports (due to flood and fire) - Hints development - Imperatives - Marking the stress Connectives , prepositional relatives.

TEXT BOOK

1. Department Of Humanities and Social Sciences Division, Anna University, Oxford University Press, 2013.

REFERENCES:

1. S.P.Danavel, English and Communication for Students of Science and Engineering, Orient Blackswan, Chennai, 2011.
2. Rizvi, M.Asharaf, Effective Technical Communication, New Delhi, Tata McGraw Hill Publishibg Company, 2007.
3. Murali Krishna and SunithaMoishra, Communication Skills for Engineers . Pearson, New Delhi, 2011.

BMA101	**MATHEMATICS I**	**L**	**T**	**P**	**C**
	Total Contact Hours - 60	3	1	0	3
	Prerequisite – + 2 Level Mathematics				
	Course Designed by – Dept of Mathematics				

OBJECTIVES

To make the students learn Mathematics in order to formulate and solve problems effectively in their respective fields of engineering.

UNIT 1 MATRICES 12

Characteristic equations- Eigen values and eigen vectors of the real matrix- Properties- Cayley-Hamilton theorem(Excluding proof)- Orthogonal transformation of a symmetric matrix to diagonal form- Quadratic form- Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT II THREE DIMENSIONAL ANALYTICAL GEOMETRY 12

Equation of a Sphere- Plane section of a sphere- Tangent plane- Equation of cone- Right circular cone- Equation of a cylinder- Right circular cylinder.

UNIT III DIFFERENTIAL CALCULUS 12

Curvature in Cartesian coordinates- Centre and radius of curvature- Circle of curvature- Evolutes-Envelopes- Applications of Evolutes and Envelopes.

UNIT 1V FUNCTIONS OF SEVERAL VARIABLES 12

Partial derivatives- Euler's theorem for homogeneous functions- Total derivatives- Differentiation of implicit functions- Jacobians- Taylor's expansion- Maxima and Minima- Method of Lagrangian multipliers.

UNIT V MULTIPLE INTEGRALS 12

Double integration- Cartesian and Polar coordinates- Change of order of integration- Change of variables between Cartesian and Polar coordinates- Triple integration in Cartesian coordinates- Area as double integral- Volume as triple integral.

TEXT BOOK:

1. Ravish R.Singh and Mukkul Bhatt, "Engineering Mathematics-I" First Reprint, Tata McGraw Hill Pub Co., New Delhi. 2011.
2. Grewal.B.S, "Higher Engineering Mathematics", 40th Edition, Khanna Publications, Delhi. 2007.

REFERENCES:

1. Ramana.B.V. "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2007.
2. Glyn James, "Advanced Engineering Mathematics", 7thEdition, Pearson Education, 2007.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley and Sons, New York, 2003.
4. Murray R.Spiegel, "Advanced Calculus", Schaum's Outline Series, First Edn, McGraw Hill Intl Book Co.,New Delhi, 1981.

PH101	**ENGINEERING PHYSICS I**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	**3**	**0**	**0**	**3**
	Prerequisite – +2 level Physics				
	Course Designed by – Department of Physics				

OBJECTIVES:

To enhance the fundamental knowledge in Physics and its applications relevant to various stream Engineering and Technology

UNIT I CRYSTAL PHYSICS 9

Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Diamond and graphite structures (qualitative treatment)- Crystal growth techniques –solution, melt (Bridgman and Czochralski) and vapour growth techniques (qualitative)

UNIT II PROPERTIES OF MATTER AND THERMAL PHYSICS 9

Elasticity-Hooke's law - Relationship between three modulii of elasticity (qualitative) – stress - strain diagram – Poisson's ratio –Factors affecting elasticity –Bending moment – Depression of a cantilever –Young's modulus by uniform bending- I-shaped girders Modes of heat transfer- thermal conductivity- Newton's law of cooling - Linear heat flow – Lee's disc method – Radial heat flow – Rubber tube method – conduction through compound media (series and parallel).

UNIT III QUANTUM PHYSICS 9

Black body radiation – Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jeans' Law from Planck's theory – Compton effect. Theory and experimental verification – Properties of Matter waves – G.P Thomson experiment-Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box - Electron microscope - Scanning electron microscope - Transmission electron microscope.

UNIT IV ACOUSTICS AND ULTRASONICS 9

Classification of Sound- decibel- Weber–Fechner law – Sabine's formula- derivation using growth and decay method – Absorption Coefficient and its determination –factors affecting acoustics of buildings and their remedies. Production of ultrasonics by magnetostriction and piezoelectric methods - acoustic grating -Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Medical applications – Sonogram.

UNIT V PHOTONICS AND FIBRE OPTICS 9

Spontaneous and stimulated emission- Population inversion –Einstein's A and B coefficients - derivation. Types of lasers – Nd:YAG, CO2, Semiconductor lasers (homo junction & hetero junction)- Industrial and Medical Applications. Principle and propagation of light in optical fibres – Numerical aperture and Acceptance angle - Types of optical fibres (material, refractive index, mode) – attenuation, dispersion, bending - Fibre Optical Communication system (Block diagram) - Active and passive fibre sensors- Endoscope.

TEXT BOOKS:

1. Jayaraman D Engineering Physics I. Global Publishing House, 2014.
2. Arumugam M. Engineering Physics. Anuradha publishers, 2010.
3. Gaur R.K. and Gupta S.L. Engineering Physics. DhanpatRai Publishers, 2009.
4. Mani Naidu S. Engineering Physics, Second Edition, PEARSON Publishing, 2011.

REFERENCES:

1. Searls and Zemansky. University Physics, 2009
2. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009.
3. Palanisamy P.K. Engineering Physics. SCITECH Publications, 2011.
4. http://ocw.mit.edu/courses/find-by-topic
5. http://nptel.ac.in/course.php?disciplineId=122
6. https://en.wikipedia.org/wiki/Engineering_physics

BCH101	ENGINEERING CHEMISTRY - I	L	T	P	C
	Total Contact Hours - 45	3	0	0	3

	Prerequisite – +2 Level Chemistry
	Course Designed by – Department of Chemistry

OBJECTIVES

To impart a sound knowledge on the principles of chemistry involving the different applica oriented topics required for all engineering branches.

UNIT I WATER TECHNOLOGY 9

Introduction-Characteristics : Hardness of water – types - temporary and permanent hardness - estimation by EDTA method Alkalinity – types of alkalinity - Phenolphthalein and Methyl orange alkalinity - determination –Domestic water treatment – disinfection methods (Chlorination, Ozonation , UV treatment) Boiler feed water – requirements – disadvantages of using hard water in boilers Internal conditioning (Calgon Conditioning method) – External conditioning – Demineralization process – Desalination and Reverse osmosis.

UNIT II POLYMERS 9

Introduction-Polymers- definition – polymerization – degree of polymerization - types of polymerization– Addition polymerization and Condensation polymerization – Mechanism of Polymerization - free radical polymerization mechanism only, Plastics: Classification – thermoplastics and thermosetting plastics – difference between thermoplastics and thermosetting plastics - preparation, properties and uses of PVC, Teflon, nylon-6,6, PET, Rubber :Types – drawbacks of natural rubber -vulcanization of rubber - properties and uses of vulcanized rubber Synthetic rubbers – butyl rubber and SBR

UNIT III ELECTRO CHEMISTRY 9

Introduction CELLS: types of Electrochemical cells , Electrolytic cells – Reversible and irreversible cells EMF – measurement of EMF– Single electrode potential – Nernst equation Reference electrodes : Standard Hydrogen electrode -Calomel electrode Ion selective electrode :Glass electrode and measurement of pH using Glass electrode Electrochemical series – significance Titrations :Potentiometer titrations (redox - Fe^{2+}vs dichromate titrations) Conduct metric titrations (acid-base – HCI vs, NaOH titrations)

UNIT IV CORROSION AND CORROSION CONTROL 9

Introduction: Chemical corrosion Definition - Chemical Corrosion - Electrochemical corrosion – different types – galvanic corrosion – differential aeration corrosion – mechanism of Chemical and Electrochemical corrosion factors influencing corrosion control – sacrificial anode and impressed cathodic current methods – Protective coatings :Paints– constituents of the paint and their functions Metallic coatings – electroplating of Gold and electro less plating of Nickel.

UNIT V NON-CONVENTIONAL ENERGY SOURCES AND STORAGE DEVICES 9

Introduction : Nuclear fission and nuclear fusion reactions – differences between nuclear fission and nuclear fusion reactions – nuclear chain Reactions – nuclear energy critical mass - super critical mass - sub - critical mass Light water nuclear reactor for power generation (block diagram only) – breeder reactor Solar energy conversion – solar cells – wind energy Fuel cells – hydrogen – oxygen fuel cell Batteries :Primary and secondary Batteries – differences between Primary and secondary Batteries Secondary batteries :Lead–acid storage battery –working –uses Nickel–cadmium battery - working –uses Solid – state battery : Lithium battery

TEXT BOOKS:

1. P.C.Jain and Monica Jain, "Engineering Chemistry" DhanpatRai Pub, Co., New Delhi (2002).
2. S.S. Dara "A text book of engineering chemistry" S.Chand&Co.Ltd., New Delhi (2006).
3. P. J. Lucia, M. Subhashini, "Engineering Chemistry, Volume 1", Crystal Publications, Chennai, (2007).

REFERENCES :

1. B.K.Sharma "Engineering chemistry" Krishna Prakasan Media (P) Ltd., Meerut (2001).
2. B. Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2008).
3. http://ocw.mit.edu/courses/find-by-topic
4. http://nptel.ac.in/course.php?disciplineId=122
5. https://en.wikipedia.org/wiki/Electrochemistry

BCS101	FUNDAMENTALS OF COMPUTING AND PROGRAMMING	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
	Prerequisite – +2 level Physics				
	Course Designed by – Department of Physics				

OBJECTIVES

Students will understand the basics of computers and solve computer oriented problems using various computing tools.

UNIT I INTRODUCTION TO COMPUTER 9

Introduction- Characteristics of computer-Evolution of Computers-Computer Generations - Classification of Computers- Basic Computer Organization-Number system. Computer Software: Types of Software—System software-Application software-Software Development Steps

UNIT II PROBLEM SOLVING AND OFFICE AUTOMATION 9

Planning the Computer Program – Purpose – Algorithm – Flowcharts– Pseudo code Introduction to Office Packages: MS Word, Spread Sheet, Power Point, MS Access, Outlook.

UNIT III INTRODUCTION TO C 9

Overview of C-Constants-Variables-Keywords-Data types-Operators and Expressions. Managing Input and Output statements-Decision making-Branching and Looping statements.

UNIT IV ARRAYS AND STRUCTURES 9

Overview of C-Constants, Variables and Data types-Operators and Expressions -Managing Input and Output operators-Decision making-Branching and Looping.

UNIT V INTRODUCTION TO C++ 9

Overview of C++ - Applications of C++-Classes and objects-OOPS concepts -Constructor and Destructor- A simple C++ program –Friend classes and Friend Function.

TEXT BOOKS:

1. Ashok, N.Kamthane,"Computer Programming", Pearson Education (2012).
2. Anita Goel and Ajay Mittal,"Computer Fundamentals and Programming in C", Dorling V Kindersley (India Pvt Ltd).,Pearson Education in South Asia,(2011).
3. Yashavant P. Kanetkar, "Let us C",13thEdition,BPB Publications(2013).
4. Yashavant P. Kanetkar,"Let us C++"10th Edition, BPB Publications (2013**).**

REFERENCES:

1. Pradeep K.Sinha, Priti Sinha "Foundations of Computing", BPB Publications (2013).
2. Byron Gottfried, "Programming with C", 2nd edition, (Indian Adapted Edition), TMH Publication.
3. PradipDey, Manas Ghosh, Fundamentals of Computing and Programming in 'C' First Edition, Oxford University Press(2009).
4. The C++ Programming Language , 4th Edition, Bjarne Stroustrop, Addison-Wesley Publishing Company (2013).

BSS101	**PERSONALITY DEVELOPMENT**	**L**	**T**	**P**	**C**
	Total Contact Hours - 30	1	1	0	2
	Prerequisite – +2 Level Knowledge				
	Course Designed by – Department of Management Studies				

OBJECTIVES

To make students groom their personality and prove themselves as good Samaritans of society.

UNIT I INTRODUCTION TO PERSONALITY DEVELOPMENT 6

The concept personality- Dimensions of theories of Freud & Erickson- personality – significant of personality development. The concept of success and failure: What is success? - Hurdles in achieving success - Overcoming hurdles - Factors responsible for success – What is failure - Causes of failure. SWOT analyses.

UNIT II ATTITUDE & MOTIVATION 6

Attitude - Concept - Significance - Factors affecting attitudes - Positive attitude - Advantages – Negative attitude - Disadvantages - Ways to develop positive attitude - Difference between personalities having positive and negative attitude. Concept of motivation - Significance - Internal and external motives - Importance of self-motivation- Factors leading to de-motivation

UNIT III SELF-ESTEEM 6

Term self-esteem - Symptoms - Advantages - Do's and Don'ts to develop positive self-esteem – Low self-esteem - Symptoms - Personality having low self esteem - Positive and negative self-esteem. Interpersonal Relationships – Defining the difference between aggressive, submissive and assertive behaviours - Lateral thinking.

UNIT IV OTHER ASPECTS OF PERSONALITY DEVELOPMENT 6

Body language - Problem-solving - Conflict and Stress Management - Decision-making skills - Leadership and qualities of a successful leader - Character-building -Team-work - Time management -Work ethics –Good manners and etiquette.

UNIT V EMPLOYABILITY QUOTIENT6

Resume building- The art of participating in Group Discussion – Acing the Personal (HR & Technical) Interview -Frequently Asked Questions - Psychometric Analysis - Mock Interview Sessions.

TEXT BOOKS:

1. Hurlock, E.B (2006). Personality Development, 28th Reprint. New Delhi: Tata McGraw Hill.
2. Stephen P. Robbins and Timothy A. Judge (2014), Organizational Behavior 16th Edition, Prentice Hall.

REFERENCE BOOKS:

1. Andrews, Sudhir. How to Succeed at Interviews. 21st (rep.) New Delhi.Tata McGraw-Hill 1988.
2. Heller, Robert. Effective leadership. Essential Manager series. Dk Publishing, 2002
3. Hindle, Tim. Reducing Stress. Essential Manager series. Dk Publishing, 2003
4. Lucas, Stephen. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill. 2001
5. Mile, D.J Power of positive thinking. Delhi. Rohan Book Company, (2004).
6. Pravesh Kumar. All about Self- Motivation. New Delhi. Goodwill Publishing House. 2005.
7. Smith, B . Body Language. Delhi: Rohan Book Company. 2004

BBT102	BIOLOGY FOR ENGINEERS	L	T	P	C
	Total Contact Hours – 30	2	0	0	2
	Prerequisite – Basic Science				
	Course Designed by – Department of Industrial Bio Technology				

OBJECTIVES

Gain vivid knowledge in the fundamentals and uses of biology, human system and plant system**.**

UNIT I INTRODUCTION TO LIFE 6

Characteristics of living organisms-Basic classification-cell theory-structure of prokaryotic and eukaryotic cell-Introduction to biomolecules: definition-general classification and important functions of carbohydrates-lipids-proteins-nucleic acids vitamins and enzymes-genes and chromosome.

UNIT II BIODIVERSITY 6

Plant System: basic concepts of plant growth-nutrition-photosynthesis and nitrogen fixation-Animal System: elementary study of digestive-respiratory-circulatory-excretory systems and their functions-Microbial System: history-types of microbes-economic importance and control of microbes.

UNIT III GENETICS AND IMMUNE SYSTEM 6

Evolution: theories of evolution-**Mendel's** cell division–mitosis and meiosis-evidence of e **laws of inheritance**-variation and speciation- nucleic acids as a genetic material-central dogma immunity-antigens-antibody-immune response.

UNIT IV HUMAN DISEASES 6

Definition- causes, symptoms, diagnosis, treatment and prevention of diabetes, cancer, hypertension, influenza, AIDS and Hepatitis

UNIT V BIOLOGY AND ITS INDUSTRIAL APPLICATION 6

Transgenic plants and animals-stem cell and tissue engineering-bioreactors-biopharming-recombinant vaccines-cloning-drug discovery-biological neural networks-bioremediation-biofertilizer-biocontrol-biofilters-biosensors-biopolymers-bioenergy-biomaterials-biochips-basic biomedical instrumentation.

TEXT BOOKS:

1. A Text book of Biotechnology, R.C.Dubey, S. Chand Higher Academic Publications, 2013
2. Diseases of the Human Body, Carol D. Tamparo and Marcia A. Lewis, F.A. Davis Company, 2011.
3. Biomedical instrumentation, Technology and applications, R. Khandpur, McGraw Hill Professional, 2004

REFERENCE BOOKS

1. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
2. Cell Biology and Genetics (Biology: The unity and diversity of life Volume I), Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008
3. Biotechnology Expanding horizon, B.D. Singh, Kalyani Publishers, 2012

BCE 101	**BASIC CIVIL ENGINEERING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	2	0	0	2
	Prerequisite – +2 Level Maths& Physical Science				
	Course Designed by – Department of Civil Engineering				
OBJECTIVES: Understand the basic concepts of civil engineering.					

UNIT I CIVIL ENGINEERING MATERIALS 8

Introduction – Civil Engineering – Materials – Stones – Bricks – Sand – Cement – Plain Concrete – Reinforced Cement Concrete – Steel Sections – Timber – Plywood – Paints – Varnishes (simple examples only)

UNIT II SURVEYING 5

Surveying – objectives – classification – principles of survey-Measurement of distances – Chain survey – Determination of areas – Use of compass – Use of leveling Instrument – (simple examples only)

UNIT III FOUNDATION FOR BUILDING 5

Bearing Capacity of Soil – Foundation – Functions – Requirement of good foundations – Types of foundations – Merits & Demerits.

UNIT IV SUPERSTRUCTURE 7

Stone Masonry – Brick Masonry – Columns – Lintels – Beams – Roofing – Flooring – Plastering– White Washing (Simple examples only)

UNIT V MISCELLANEOUS TOPICS 5

Types of Bridges –Dam- purpose – selection of site - Types of Dams – Water Treatment & Supply sources – standards of drinking- distribution system. – Sewage Treatment (simple examples only)

TEXT BOOKS:

1. Raju.K.V.B, Ravichandran .P.T, "Basics of Civil Engineering", Ayyappa Publications, Chennai, 2012.
2. SeetharamanS., "Basic Civil Engineering", Anuradha Agencies, (1st ed. 2005).
3. Dr.M.SPalanisamy, "Basic Civil Engineering" (3rded. 2000), TUG Publishers, New Delhi/Tata McGrawHill Publication Co., New Delhi

REFERENCE BOOKS:

1. Rangwala.S.C, "Engineering Materials", Charotar Publishing House, Anand, 41st Edition: 2014.
2. National Building Code of India, Part V, "Building Materials", 2005
3. Ramesh Babu"A Textbook on Basic Civil Engineering" (1998). Anuradha Agencies, Kumbakonam.
4. RamamruthamS., "Basic Civil Engineering", DhanpatRai Publishing Co. (P) Ltd. (1999).

BME 101	**ENGINEERING GRAPHICS- E**	**L**	**T**	**P**	**C**
	Total Contact Hours - 60	2	0	3	4
	Prerequisite – +2 Level Maths& Physical Science				
	Course Designed by – Department of Mechanical Engineering				
OBJECTIVES **To understand techniques of drawings in various fields of engineering**					

UNIT I BASIC CURVES, PROJECTION OF POINTS AND STRAIGHT LINES 6+6

Conics-construction of ellipse, parabola and hyperbola by eccentricity method-construction of cycloids- construction of involutes of square and circle-Drawing of tangent and normal to the above curves-Scales-Basic drawing conventions and standards-Orthographic projection principles- Principal planes-First angle projection- Projection of points. Projection of straight lines (only first angle projections) inclined to both the principal planes- Determination of true lengths and true inclinations by rotating line method and trapezoidal method and traces.

UNIT II PROJECTIONS OF PLANES AND SOLIDS 6+6

Projection of planes (Polygonal and circular surfaces) inclined to both the principal planes. Projection of simple solids like prisms, pyramids, cylinder, cone, tetrahedron and truncated solids when the axis is inclined to one of the principal planes/ both principal planes by rotating object method and auxiliary plane method.

UNITIII ORTHOGRAPHIC PROJECTIONS, ISOMETRIC PROJECTIONS & FREEHANDSKETCHING 6+6

Orthographic projection of Simple parts from 3D diagram-Principles of isometric projection and isometric view-isometric scale- Isometric projections of simple solids and truncated solids- Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems Free hand sketching of orthographic & Isometric projection

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6+6

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other-obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids- Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes

.

UNIT V PERSPECTIVE PROJECTION, BUILDING DRAWING AND COMPUTER AIDEDDRAFTING 6+6

Perspective projection of simple solids-Prisms, Pyramids and cylinders by visual ray method. Introduction- components of simple residential or office building-specifications-plan and elevation of different types of Residential buildings and office buildings. Introduction to drafting packages and basic commands used in AUTO CAD. Demonstration of drafting packages.

TEXT BOOKS:

1. N.D.Bhatt and V.M.Panchal, "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2. K.V.Natarajan "A Text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.

REFERENCES:

1. K.R.Gopalakrishna, "Engineering drawing",(Vol-I & II combined) Subhas stores, Bangalore,2007.
2. K.Venugopal and V. Prabhu Raja, "Engineering Graphics", New Age International Private limited,2008.
3. Luzzader, Warren.J., and Duff, John.M.,, "Fundamentals of Engineering Drawing with an introduction to Interactive computer graphics for design and production", Eastern Economy Edition, Prentice Hall of India Pvt Ltd, New Delhi,2005.

Special points applicable to University Examinations on Engineering Graphics

1) There will be five questions, each of either or type covering all units of the syllabus.
2) All questions will carry equal marks of 20 each making a total of 100.

BCM1L1	**BASIC CIVIL & MECHANICALENGINEERING PRACTICES LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours - 30	0	0	2	1
	Prerequisite – Basic Civil and Mechanical Engineering				
	Course Designed by – Department of Mechanical Engineering& Civil Engineering				

OBJECTIVES

To provide exposure to the students with hands on experience on various basic Civil & Mechanical Engineering practices.

LIST OF EXPERIMENTS

I. CIVIL ENGINEERING PRACTICE

Buildings:

a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
b) Study of pipe connections requirements for pumps and turbines.
c) Preparation of plumbing line sketches for water supply and sewage works.
d) Hands-on-exercise: Basic pipe connection of PVC pipes & G.I. Pipes – Mixed pipe material connection – Pipe connections with different joining components.
e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Hand tools and Power tools:

a) Study of the joints in roofs, doors, windows and furniture.
b) Hands-on-exercise: Wood work, joints by sawing, planning and cutting.
c) Preparation of half joints, Mortise and Tenon joints.

II MECHANICAL ENGINEERING PRACTICE

Welding:

a) Preparation of butt joints, lap joints and tee joints by arc welding

Basic Machining:

a) Simple Turning and Taper turning
b) Drilling Practice

Sheet Metal Work:

a) Forming & Bending:
b) Model making – Trays, funnels, etc.
c) Different type of joints
d) Preparation of air-conditioning ducts
e) Preparation of butt joints, lap joints and tee joints by arc welding

Machine assembly practice:

a) Assembling, dismantling and Study of centrifugal pump
b) Assembling, dismantling and Study of air conditioner
c) Assembling, dismantling and Study of lathe

Moulding:

a) Moulding operations like mould preparation for gear and step cone pulley etc

Fitting:

a) Fitting Exercises – Preparation of square fitting and vee – fitting models.

Demonstration:

a) Smithy operations, upsetting, swaging, setting down and bending. Example–Exercise – Production of hexagonal headed bolt.
b) Gas welding.

REFERENCES:

1. K. Jeyachandran, S. Nararajan & S, Balasubramanian, "A Primer on Engineering Practices Laboratory" ,Anuradha Publications, (2007).
2. T.Jeyapoovan, M. Saravanapandian & S. Pranitha, "Engineering Practices Lab Manual", Vikas Publishing House Pvt. Ltd. (2006)

3. H. S. Bawa, "Workshop Practice", Tata McGraw–Hill Publishing Company Limited, (2007).
4. A. Rajendra Prasad & P. M. M. S Sarma, "Workshop Practice", Sree Sai Publication, (2002).
5. P. Kannaiah& K.L. Narayana, "Manual on Workshop Practice", Scitech Publication, (1999).

BEN 2	**ENGLISH II**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	3	1	0	3
	Prerequisite – English I				
	Course Designed by – Department of English				

OBJECTIVES

Students will be able to actively participate in group discussions. Students will have Telepho Skills, Giving Directions and Information Transfer

UNIT I ORIENTATION 12

Numerical adjectives - Meanings in context - Same words used as different parts of speech - Paragraph writing - Non- verbal communication - Regular and Irregular verbs.

UNIT II ORAL SKILL 12

Listening to audio cassettes - C.Ds , News bulletin - Special Lectures, Discourse - Note taking - Sentence patterns - SV, SVO, SVC, SVOC, SVOCA - and Giving Instructions - Reading Comprehension answering questions. Inferring meaning.

UNIT III THINKING SKILL 12

Self- introduction describing –Group Discussion – Debate –Role play- Telephone- Things- etiquette- Recommendation and Sequencing jumbled sentences to make a suggestions- paragraph-advertisement and notice, Designing or drafting posters, writing formal and informal invitations and replies.

UNIT IV WRITING SKILL 12

Definitions - Compound nouns - Abbreviations and acronyms – (a) business or official letters(for making enquiries, registering complaints, asking for and giving information, placing orders and sending replies): (b) Letters to the editor (giving suggestions on an issue) .

UNIT V FORMAL INFORMATION 12

Editing – Prepositions - Articles - Permission letter for undergoing practical training , Essay writing - Application for a job , letter to the principal authorities regarding admissions, other issues, requirement or suitability of course etc.

TEXT BOOK:

1. Meenakshi Raman, SangeethaSharma , Technical English for Communication: Principle and Practice, OUP, 2009.

REFERENCE BOOKS:

1. Sumanth , English for Engineers, Vijay Nicole , Imprints pvt ltd.2013.
2. Meenakshi Raman and SangeethaSharma , Technical Communication Principles and Practice, Oxford University Press, 2009.
3. Sangeetha Sharma, Binodmishra , Communication skills for engineers and scientists , PHI Learning Pvt Ltd, New Delhi, 2010.

BMA 201	**MATHEMATICS – II**	**L**	**T**	**P**	**C**
	Total Contact Hours - 60	3	1	0	3
	Prerequisite – Mathematics I				
	Course Designed by – Department of Mathematics				

OBJECTIVES

Ability to apply these principles of mathematics in projects and research works.

UNIT I ORDINARY DIFFERENTIAL EQUATION 12

Higher order linear differential equations with constant coefficients - Method of variation of parameters **– Cauchy's** and L**egendre's linear equations** - simultaneous first order linear equations with constant coefficients.

UNIT II VECTOR CALCULUS 12

Gradient, divergence and curl –Directional derivatives –Irrotational and solenoidal vector fields **–** vector integration**– Green's theorem in a plane , Gauss divergence theorem and** S**toke's theorem (**without proofs) **–** simple applications involving cubes and rectangular parallelepipeds.

UNIT III ANALYTIC FUNCTIONS 12

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy-Riemann equation and sufficient conditions (without proofs) – Harmonic and orthogonal properties of analytic functions – Harmonic conjugate – construction of analytic functions – conformal mapping: W= Z+C, CZ, 1/Z and bilinear transformation.

UNIT IV COMPLEX INTEGRATION 12

Complex integration **– Statement and application of Cauchy's integral theorem and Cauchy's integral formula** –Taylor and Laurent expansions – Singular points – Residues – Residue theorem –Application of Residue theorem to evaluate real integrals – Unit circle and semi-circular contour (excluding poles on boundaries).

UNIT V STATISTICS 12

Mean, Median, Mode – Moments –Skewness and Kurtosis – Correlation – Rank Correlation – Regression –Chi square test for contingency tables.

TEXT BOOK:

1. R.M.Kannan and B.Vijayakumar" Engineering Mathematics–II "2nd Edition, SRB Publication, Chennai 2007.
2. Bali.N.P and Manish Goyal , "Engineering Mathematics", 3rd Edition, Laxmi Publications (P) Lltd, 2008 .
3. Grewal .B/S "Higher Engineering Mathematics", 40th Editon, Khanna Publications, Delhi, 2007

REFERENCES :

1. Ramana.B.V, "Higher Engineering Mathematic", Tata McGraw Hill Publishing Company, New Delhi, 2007.

2. Gupta SC, and VK.Kapoor, "Fundamentals Mathematical Statistics", 11th edition, Sultan Chand Sons, New Delhi, 2014.

BPH201	**ENGINEERING PHYSICS -II**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	3	0	0	3
	Prerequisite – ENGINEERING PHYSICS -I				
	Course Designed by – Department of Physics				

OBJECTIVES

- To expose the students to multiple areas of science of engineering materials which have direct relevance to different Engineering applications
- To understand the concepts and applications of conducting, Semiconducting, magnetic & dielectric materials as well as their optical properties.

UNIT I CONDUCTING MATERIALS 9

Conductors – classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – Draw backs of classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals.

UNIT II SEMICONDUCTING MATERIALS 9

Intrinsic semiconductor – carrier concentration derivation Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination – compound semiconductors -direct and indirect band gap- derivation of carrier concentration in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration — Hall effect –Determination of Hall coefficient – Applications.

UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – antiferromagnetic materials – Ferrites and its applications Superconductivity : properties – Type I and Type II superconductors – BCS theory of superconductivity(Qualitative) - High Tc superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.

UNIT IV DIELECTRIC MATERIALS 9

Electrical susceptibility – dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation – internal field – Claussius – Mosotti relation (derivation) – dielectric loss – dielectric breakdown – uses of dielectric materials (capacitor and transformer) – ferroelectricity and applications.

UNIT V ADVANCED ENGINEERING MATERIALS 9

Metallic glasses: preparation, properties and applications. Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application, Nanomaterials– Preparation -pulsed laser deposition – chemical vapour deposition – Applications – NLO materials –Birefringence- optical Kerr effect – Classification of Biomaterials and its applications.

TEXT BOOKS:

1. Jayaraman D Engineering Physics II. Global Publishing House, 2014.
2. Palanisamy P.K. Materials Science. SCITECH Publishers, 2011.
3. Senthilkumar G. Engineering Physics II. VRB Publishers, 2011.

REFERENCES:

1.Arumugam M., Materials Science. Anuradha publishers, 2010
2. Pillai S.O., Solid State Physics. New Age International(P) Ltd., publishers, 2009
3. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009
4 http://ocw.mit.edu/courses/find-by-topic
5 http://nptel.ac.in/course.php?disciplineId=122
6 https://en.wikipedia.org/wiki/Engineering_physics

BCH 201	**ENGINEERING CHEMISTRY-II**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	3	0	0	3
	Prerequisite – ENGINEERING CHEMISTRY –I				
	Course Designed by – Department of Chemistry				

OBJECTIVES

To impart a sound knowledge on the principles of chemistry involving application orier topics required for all engineering branches.

UNIT I SURFACE CHEMISTRY 9

Introduction **:** Adsorption , absorption , desorption , adsorbent , adsorbate and sorption – (definition only) Differences between adsorption and absorption Adsorption of gases on solids – factors affecting adsorption of gases on solids – Adsorption isotherms –Frendlich adsorption isotherm and Langmuir adsorption isotherm Role of adsorbents in catalysis, Ion-exchange adsorption and pollution abatement.

UNIT II PHASE RULE AND ALLOYS 9

Introduction **:**Statement of Phase Rule and explanation of terms involved – one component system – water system – Construction of phase diagram by thermal analysis - Condensed phase rule [Definition only] Two Component System : Simple eutectic systems (lead-silver system only) – eutectic temperature – eutectic composition – Pattinsons Process of desilverisation of Lead Alloys: Importance, ferrous alloys –nichrome and stainless steel – 18/8 stainless steel -heat treatment of steel – annealing – hardening – tempering normalizing – carburizing - nit riding . Non- ferrous alloys: Brass and Bronze

UNIT III ANALYTICAL TECHNIQUES 9

Introduction: Type of Spectroscopy - Atomic spectroscopy – molecular spectroscopy - Explanation IR spectroscopy – principles – instrumentation (block diagram only) – applications - finger print region UV-visible spectroscopy –– principle – instrumentation (block diagram only) – Beer-**Lambert's law**- – estimation of iron by colorimetry– Atomic absorption spectroscopy- principle - instrumentation (block diagram only) - estimation of Nickel by Atomic absorption spectroscopy Flame photometry– principles – instrumentation (block diagram only) - estimation of sodium ion by Flame photometry

UNIT IV FUELS 9

Introduction **:** Calorific value – types of Calorific value - gross calorific value – net calorific value Analysis of Coal –- Proximate and ultimate analysis – hydrogenation of coal - Metallurgical coke – manufacture by Otto-Hoffmann method Petroleum processing and fractions – cracking – catalytic cracking – types – fixed bed catalytic cracking method- Octane number and Cetane number (definition only) Synthetic petrol – Bergius processes – Gaseous fuels- water gas, producer gas, CNG and LPG (definition and composition only) Flue gas analysis – importance - Orsat apparatus

UNIT V ENGINEERING MATERIALS 9

Introduction: Refractory's – classification – acidic, basic and neutral refractory's – properties (refractoriness, refractoriness under load, dimensional stability, porosity, thermal spalling) Manufacture of Refractory's: alumina bricks and Magnesite bricks, Abrasives – natural and synthetic abrasives Natural type : Siliceous - quartz ; Non –siliceous – diamond Synthetic Abrasives : silicon carbide and boron carbide. Lubricants: Liquid lubricants - Properties – viscosity index, flash and fire points, cloud and pour points, oiliness) Solid lubricants – graphite and molybdenum sulphide

TEXT BOOKS:

1. P.C.Jain and Monica Jain, "Engineering Chemistry" DhanpatRaiPub, Co., New Delhi (2002).
2. S.S.Dara "A text book of Engineering Chemistry" S.Chand&Co.Ltd., New Delhi (2006).
3. P. J. Lucia, M. Subhashini, "Engineering Chemistry, Volume 1", Crystal Publications, Chennai, (2007).

REFERENCES:

1. B.Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub. Co.Ltd, New Delhi,(2008)
2. B.K.Sharma "Engineering Chemistry" Krishna Prakasan Media (P) Ltd., Meerut (2001).
3. http://ocw.mit.edu/courses/find-by-topic
4. http://nptel.ac.in/course.php?disciplineId=122
5. https://en.wikipedia.org/wiki/Spectroscopy

BFR 201	FRENCH	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – +2 Level English				
	Course Designed by – Department of English				

OBJECTIVES

Language gives access and insights into another culture. It is a fundamental truth that cultures de themselves through languages.

UNIT I INTRODUCTION 8

At the airport: Savoir– faire: exchanging greetings, self introduction, introducing another, welcoming someone, identifying someone - Grammar: verbs 'to be', 'to call oneself', subject pronouns, interrogation

UNIT II GRAMMAR 8

At the University: Savoir-faire: enquiring after one's welfare, taking leave, expressing appreciation -Grammar: definite & indefinite articles, gender of nouns, adjectives, present tense of regular 'er' verbs, 'to have', 'to learn', negation, irregular verbs

UNIT III CONVERSATION 8

At the café: Savoir –faire: speaking about one's likes, giving information, expressing admiration, asking information about someone - Grammar: Interrogative adjectives, irregular verbs, possessive and interrogative adjectives

UNIT IV PROPOSAL WRITING 7

At the beach: Savoir faire: proposing an outing, accepting/ refusing the proposal - Grammar: singular & plural, indefinite pronoun, demonstrative adjectives, negation, irregular verbs

UNIT V FORMAL LETTERS 7

A concert: Savoir –faire: inviting, accepting, expressing one's inability to accept an invitation

UNIT VI REGULAR & IRREGULAR VERBS 7

Grammar: Present tense of more irregular verbs, contracted articles, future tense, interrogative adverbs, **At Nalli's**Savoir- faire: asking the price of an article, protesting against the price, Grammar: possessive adjectives, Exclamative adjectives, imperative tense

REFERENCES:

1. Course Material: Synchronie I –Méthode de Français
2. Madanagobalane -Samita Publications, Chennai, 2007

BGM 201	**GERMAN**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite +2 Level English				
	Course Designed by – Department of English				
OBJECTIVES At the end of this course, students shall be able to obtain good knowledge of the language read, write and speak German, whereby the emphasis is laid on speech.					

Course structure:

A. German Language (speaking, reading, writing, grammar and test)
B. Life in Germany (shopping, restaurant, doctor, government, bank, post)
C. The German Way (introduction, doing business, conversation, meetings, dining)
D. Germany (Culture, Climate)

UNIT IPRONOUNCIATION 9

Welcome: Introduction to the Language, Spelling and Pronunciation (The alphabets and numbers) Greetings, ordering, requesting, saying thank you - Grammar **– the article "the", conjugation** of verbs

UNIT IISELF INTRODUCTION *9*

Shopping - Grammar – adjectives, endings before nouns, practice. Self introduction

UNIT IIITRAINING ***9***

Addresses, Occupations, Studies - Grammar - ***'to be', the definite/indefinite*** *articles, individual* Training

UNIT IVORAL ***9***

Leisure Time, Sports, Hobbies - Grammar – position of a verb in a main clause , oral practice

UNIT VNARRATION ***9***

At a Restaurant, Food and Drink - Grammar – the personal pronoun in the Nominative and Accusative, Narrating an event

RESOURCES:

1. Sprachkurs Deutsch 1 (VerlagDiesterweg), New Delhi Learning Centre

BJP 201	**JAPANESE**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	3	0	0	3
	Prerequisite – +2 Level English				
	Course Designed by – Department of English				

OBJECTIVES

To have a basic knowledge of Japanese language, Japanese culture and heritage
To impart knowledge Japanese lifestyle.
To give sufficient exposure to develop basic conversational skills.

UNIT ICULTURAL HERITAGE **9**

Introduction-history and origin of Japanese language-Japan and its cultural heritage-Self introduction-counting numbers (1-100)-time-conversation with the use of audio devices, grammar– usage of particles wa, no, mo and ka

UNIT IIUSAGE **9**

Greetings, seasons, days of the week and months of the year-numbers (up to 99,999)-grammar– usage of kore, sore, are, kono, sono, ano, koko and kochira, arimasu and imasu-i-ending and na-ending adjectives-use of audio and drills for practice

UNIT IIIORAL **9**

Asking the price–associated vocabulary-usage of particles ni, ga and ne- use of audio and drills for practice-Introduction to basic Kanji characters- use of audio and drills for practice

UNIT IVART AND CULTURE **9**

Family relationships- colours-Kanji (numbers) and festivals of Japan-religion-Japanese art and culture-ikebana, origami-introduction to hiragana- use of audio and drills for practice

UNIT VDRILLS AND PRACTICE **9**

Vocobulary associated with directions-asking way-particles – e, de, mo, koko, soko, asoko,

doko, nani, mae, ushiro, ue, shita- use of audio and drills for practice-introduction to katakana

TEXT BOOKS

1. Japanese Hiragana and Katakana for beginners, Timothy G. Stout, 2011
2. Genki I: An integrated course in elementary Japanese, EriBanno and Yuko Ikeda, 2011

REFERENCE BOOKS

1. Japanese Reader collection Volume I, YumiBoutwell and Clay Boutwell, Kotoba books, 2013
2. Living Language Japanese Complete Edition beginners through advanced course, Living Language, 2012

BKR 201	**KOREAN**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	3	1	0	3
	Prerequisite – +2 Level English				
	Course Designed by – Department of English				

UNIT I PLANNING 9 9

Asking/giving reasons for studying Korean, making plans for the holiday, writing letters, describing past travel experiences and future travel plans, shopping in a grocery store, shopping in electronics store, storytelling Grammar: would like to (do), want to (do), construct future tense.

UNIT II MODIFIERS 9

Asking about feelings, asking about problems and giving advice, brief introductions - Grammar: Noun modifier, please try doing (something), irregular adjective/verb

UNIT III PLACING ORDERS 9

Asking about hobbies, asking about abilities (sports), job requirements, Ordering things for delivery, ordering a meal at a restaurant - Grammar: Sentence ending for the honorific form, please do something for me, have tried (something),

UNIT IV DESCRIPTIONS 9

Asking about evening plans, making plans with others, making preparations - Asking about rooms, describing your room to your classmates, describing your house. Grammar: to know/not know how to do something, must (do), have to (do), should,

UNIT V GRAMMAR 9

Describing your plans and giving reasons, cancelling appointments. Grammar: Shall we~? / Should we~?, with, and, irregular verbs/adjective, so, because, cannot, intend to, plan to, or hope to, (more) than, the most, tag question/is n't it? ,will (do)

COURSE MATERIAL:

Korean for Non-Native Speakers (Student Book 1B) Korean Language Education Center, Sogang University

BCN 201	CHINESE	L	T	P	C
	Total Contact Hours - 60	3	0	0	3
	Prerequisite – +2 Level English				
	Course Designed by – Department of English				

OBJECTIVES

To have a basic knowledge of Chinese language, Chinese culture and heritage
To impart knowledge on Chinese lifestyle and heritage.

UNIT 1 RISE OF DIALECTS 9

History, Origins, Old and middle Chinese, Rise of northern dialects

UNIT IIV ARIETIES 9

Influences 3 Varieties of Chinese. 1.Classification 2.Standard Chinese and 3.Nomenclature

UNIT III CHARACTERS 9

Chinese characters, Homophones, Phonology

UNIT IV TRANSCRIPTIONS 9

Tones, Phonetic transcriptions, Romanization, Other phonetic transcriptions

UNIT V GRAMMAR 9

Grammar and morphology, Vocabulary, Loanwords, Modern borrowings and loanwords

REFERENCES:

1. Hannas, William C. (1997), Asia's Orthographic Dilemma, University of Hawaii Press, ISBNHYPERLINK "http://en.wikipedia.org/wiki/Special:BookSources/978-0-8248-1892-0" 978-0-8248- 1892-0.
2. Qiu, Xigui (2000), Chinese Writing, trans. Gilbert Louis Mattos and Jerry Norman, Society for the Study of Early China and Institute of East Asian Studies, University of California, Berkeley, ISBN HYPERLINK http://en.wikipedia.org/wiki/Special:BookSources/978-1-55729-071-7,978-1-55729-071-7.
3. Ramsey, S. Robert (1987), The Languages of China, Princeton University Press, ISBNHYPERLINK "http://en.wikipedia.org/wiki/Special:BookSources/978-0-691-01468-5" 978-0-691-01468-5.
4. Schuessler, Axel (2007), ABC Etymological Dictionary of Old Chinese, Honolulu: University of Hawaii Press, ISBNHYPERLINK "http://en.wikipedia.org/wiki/Special:BookSources/978-0-8248-2975-9"978-0-8248-2975-9.
5. R. L. G. " Language borrowing Why so little Chinese in English?" The Economist. June 6, 2013.

BME 202	ENGINEERING MECHANICS	L	T	P	C
	Total Contact Hours – 60	3	1	0	3
	Prerequisite – Engineering Mathematics I , II, Engg. Physics				
	Course Designed by – Department of Mechanical Engineering				

OBJECTIVES: To understand the concept of basic engineering mechanism

UNIT I BASICS AND STATICS OF PARTICLES 12

Introduction - Units and Dimensions - Laws of Mechanics – **Lame's theorem, Parallelogram and triangular Law** of forces – Vectors –Vectorial representation of forces and moments – Vector operations on forces - Coplanar Forces – Resolution and Composition of forces – Resultant of several concurrent forces - Equilibrium of a forces – Forces in space - Equilibrium of particle in space - Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

UNIT II EQUILIBRIUM OF RIGID BODIES 12

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis –Vectorial representation of moments and couples– Scalar components of a moment – **Varignon's theorem** - Equilibrium of Rigid bodies in two dimensions -Equilibrium of Rigid bodies in three dimensions.

UNITIII PROPERTIES OF SURFACES AND SOLIDS 12

Determination of areas – First moment of area and the Centroid of standard sections – T section, I section, Composite figures, Hollow section – second moments of plane area – Rectangle, triangle, circle - T section, I section, Hollow section – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia – Basic concept of Mass moment of inertia.

UNITIV FRICTION 12

Frictional force – Laws of Coloumb friction – Cone of friction – Angle of repose – Simple contact friction – Sliding of blocks – Wedge friction - Ladder friction – Screw Jack – Belt friction - Rolling resistance.

UNIT V DYNAMICS OF PARTICLES 12

Displacements, Velocity and acceleration, their relationship – Relative motion – Relative acceleration – Curvilinear motion of particles – **Newton's law** – work energy equation – impulse and Momentum – Impact of
elastic bodies.

TEXT BOOK:

1. Beer, F.P and Johnson Jr. E.R, "Vector Mechanics for Engineers: Vol. 1 Statics and vol. 2 Dynamics", McGraw-Hill International Edition, 2013.
2. Rajasekaran, S, Sankarasubramanian, G., Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt., Ltd., 2011.

REFERENCES :

1. Kumar, K. L Kumar, V., Engineering Mechanics, Tata McGraw – Hill, New Delhi, 2010
2. Palanichamy, M.S., Nagan, S., Engineering Mechanics – Statics & Dynamics, Tata McGraw - Hill, 2013.
3. Timoshenko, and Young, Engineering Mechanics, Tata McGraw-Hill, New Delhi, 2013.
4. Irving H. Shames, Engineering Mechanics – Statics and Dynamics, IV Edition – Pearson Education Asia Pvt., Ltd., 2006.

BEE 201	**BASIC ELECTRICAL AND ELECTRONICS ENGINEERING**	**L**	**T**	**P**	**C**
	Total Contact Hours - 30	2	0	0	2
	Prerequisite – Engineering Mathematics, Engineering Physics-I & II				
	Course Designed by – Department of Electrical & Electronics Engineering				
OBJECTIVES: To understand the laws of electrical engineering.					

UNIT I ELECTRIC CIRCUITS 6

Ohm's law – Kirchoff's Laws, V – I Relationship of Resistor (R) Inductor (L) and capacitor (C). Series parallel combination of R, L&C – Current and voltage source transformation – mesh current & node voltage method –superposition theorem –Thevenin's and Norton's Theorem - Problems.

UNIT II ELECTRICAL MACHINES 6

Construction, principle of operation, Basic Equations and applications - D.C.Generators and D.C.Motors**.** -Single phase Induction Motor - Single Phase Transformer.

UNIT III BASIC MEASUREMENT SYSTEMS 6

Introduction to Measurement Systems, Construction and Operating principles of PMMC, Moving Iron, Dynamometer Wattmeter, power measurement by three-watt meter and two watt method **–** and Energy meter.

UNIT IV SEMICONDUCTOR DEVICES 6

Basic Concepts of semiconductor devices **–** PN Junction Diode Characteristics and its Applications **–** HWR, FWR **–**Zener Diode **–** BJT (CB, CE, CC) configuration & Characteristics.

UNIT V DIGITAL ELECTRONICS 6

Number system **–** Logic Gates **–** Boolean Algebra**–** De-**Morgan's Theorem –** Half Adder & Full Adder **–** Flip Flops.

TEXT BOOKS:

1. N.Mittal "Basic Electrical Engineering". Tata McGraw Hill Edition, New Delhi, 1990.
2. A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', DhanpatRai and Co, 2004.
3. Jacob Millman and Christos C-Halkias, "Electronic Devices and Circuits", Tata McGraw Hill

REFERENCE BOOKS:

1. Edminister J.A. "Theory and Problems of Electric Circuits" Schaum's Outline Series. McGrawHill Book Compay, 2nd Edition, 1983.
2. Hyatt W.H and Kemmerlay J.E. "Engineering Circuit Analysis", McGraw Hill International Editions, 1993.
3. D. P. Kothari and I. J. Nagrath" Electric Machines"Tata McGraw-Hill Education, 2004
4. Millman and Halkias, "Integrated Electronics", Tata McGraw Hill Edition, 2004.

BCS 2L2	**COMPUTER PRACTICE LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours - 45	0	0	3	1
	Prerequisite – Fundamentals of Computer				
	Course Designed by – Department of Computer Science &Engineering				
OBJECTIVES: To impart basic computer knowledge					

A) WORD PROCESSING **6**

Document creation, Text manipulation with Scientific Notations. Table creation, Table formatting and Conversion. Mail merge and Letter Preparation. Drawing-Flow Chart

B) SPREAD SHEET **9**

Chart-Line Xy Bar and Pie – Formula-Formula Editor-Spread sheet-Inclusion of Object, Picture and Graphics Protecting the document and sheet-Sorting and Import/Export features.

C) SIMPLE C PROGRAMMING* **15**

Data types, Expression Evaluation, Condition Statement. Arrays structures and Unions – Functions

D) SIMPLE C++PROGRAMMING **15**

-Classes and Objects

-Constructor and Destructor

***For Programming exercises Flow chart and Pseudo code are essential.**

BEE2L1	**BASIC ELECTRICAL AND ELECTRONIC ENGINEERING PRACTICES LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	0	0	3	1
	Prerequisite – Basic Electrical and Electronics Engineering				
	Course Designed by – Department of Electrical & Electronics Engineering				
OBJECTIVES: To enhance the student with knowledge on electrical and electronic equipments.					

I LIST OF EXPERIMENTS FOR ELECTRICAL ENGINEERING LAB

1. Fluorescent lamp wiring
2. Stair case wiring
3. Measurement of electrical quantities-voltage current, power & power factor in RLC circuit
4. Residential house wiring using fuse, switch, indicator, lamp and energy meter
5. Measurement of energy using single phase energy meter
6. Measurement of resistance to earth of electrical equipment

II LIST OF EXPERIMENTS FOR ELECTRONICS ENGINEERING LAB

1. Study of electronic components and equipments.
   a. Resistor colour coding using digital multi-meter.
   b. Assembling electronic components on bread board.

2. Measurement of ac signal parameters using cathode ray oscilloscope and function generator.
3. Soldering and desoldering practice.
4. Verification of logic gates (OR, AND, OR, NOT, NAND, EX-OR).
5. Implementation of half adder circuit using logic gates.

BPC 2L1	**PHYSICS AND CHEMISTRY LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	0	0	3	1
	Prerequisite – Physics and Chemistry				
	Course Designed by – Department of Physics & Chemistry				
OBJECTIVES: To impart knowledge to the students in practical physics and chemistry					

I -LIST OF EXPERIMENTS – PHYSICS

1. Determination of Wavelength, and particle size using Laser
2. Determination of acceptance angle in an optical fiber.
3. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
4. Determination of wavelength of mercury spectrum – spectrometer grating
5. Determination of thermal conductivity of a bad conductor – Lee‟s Disc method.
6. Determination of Young‟s modulus by Non uniform bending method
7. Determination of specific resistance of a given coil of wire – Carey Foster‟s Bridge
8. Determination of Young‟s modulus by uniform bending method
9. Determination of band gap of a semiconductor
10. Determination of Coefficient of viscosity of a liquid –Poiseuille‟s method
11. Determination of Dispersive power of a prism - Spectrometer
12. Determination of thickness of a thin wire – Air wedge method
13. Determination of Rigidity modulus – Torsion pendulum

II-LIST OF EXPERIMENTS – CHEMISTRY

1. Estimation of hardness of Water by EDTA
2. Estimation of Copper in brass by EDTA
3. Determination of DO in water (Winkler's method)
4. Estimation of Chloride in Water sample (Argento metry)
5. Estimation of alkalinity of Water sample
6. Determination of molecular weight
7. Conduct metric titration (Simple acid base)
8. Conduct metric titration (Mixture of weak and strong acids)
9. Conduct metric titration using $BaCl_2$vs Na_2SO_4
10. Potentiometric Titration (Fe^{2+} / $KMnO_4$ or $K_2Cr_2O_7$)
11. pH titration (acid & base)
12. Determination of water of crystallization of a crystalline salt (Copper Sulphate)
13. Estimation of Ferric iron by spectrophotometer.

BMA301	MATHEMATICS – III	L	T	P	C

	Total Contact Hours – 75	3	2	0	4
	Prerequisite – Mathematics I & II, Engineering Physics				
	Course Designed by – Department of Mathematics				

OBJECTIVES

1. To introduce Fourier series analysis that is important to many applications in engineering apart from its use in solving boundary value problems.
2. To acquaint the student with Fourier transform techniques used in wide variety of situations.
3. To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes
4. To develop Z transform techniques for discrete time systems.
5. To develop the Fourier transform techniques and convolution theorem.

COURSE CONTENT

UNIT I	**PARTIAL DIFFERENTIAL EQUATIONS**	**9+6**

Formation of PDE by eliminating arbitrary constants, functions – Solutions of first order PDE – Standard types-homogeneous linear PDE of second order with constant coefficients - Lagrange's Linear PDE – Method of grouping, multiplier methods.

UNIT II	**FOURIER SERIES**	**9+6**

Dirichlet's conditions – General Fourier series – Half-range Sine and Cosine series – Parseval's identity – Harmonic Analysis.

UNIT III	**BOUNDARY VALUE PROBLEMS**	**9+6**

Classifications of second order linear partial differential equation – Solutions of one dimensional wave equation and one-dimensional heat equation.

UNIT IV	**LAPLACE TRANSFORMS**	**9+6**

Laplace transform of simple functions – Transform of elementary functions – Basic properties – initial and final value theorem – Transform of derivatives and integrals – transform of periodic functions – inverse Laplace transforms –Convolution theorem (excluding proof) – Solution of linear ODE of second order with constant coefficients and solutions of simultaneous first order differential equations with constant coefficients using Laplace transformation techniques.

UNIT V	**FOURIER TRANSFORMS**	**9+6**

Fourier integral theorem – Fourier transform pair-Sine and Cosine transforms – Properties – Transform of simple function – Convolution theorem – Parseval's identity.

Text Books:

1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publications, 2007.

References:

1. Glyn James, Advance Modern Engineering Mathematics, Pearson Education, 2007.
2. Kreyszig. E, Advanced Engineering Mathematics, (8th edition), John Wiley & Sons, Singapore, 2000.
3. Kandasamy P et al, Engineering Mathematics, Vol. II & III (4th revised edition), S. Chand & Co., New Delhi, 2000.
4. Narayanan S., ManicavachagomPillay T. K., Ramanaiah G., Advanced Mathematics for Engineering Students, Volume II & III (2nd edition), S. Viswanathan Printers and Publishers, 1992.
5. Venkataraman M. K., Engineering Mathematics – Vol. III – A & B (13th edition), National Publishing

Co., Chennai, 1998.
6. Julius S. Bendat and Allan G. Piersol., Random Data: Analysis and Measurement Procedures (4th edition), Wiley Series in Probability and Statistics, 2010.
7. *https://www.wolfram.com/**mathematica**/*

BAN301	FUNDAMENTALS OF AERONAUTICS AND ASTRONAUTICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Engineering Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To equip the student with the knowledge about the development of aircrafts and spacecrafts through historical reviews and about their basic configurations.
2. To accustom the student to the various basic aerodynamic terms and about the generation of aerodynamic forces.
3. To introduce to the student about the basic types of aircraft constructions and materials and the various loads acting on it.
4. To familiarize the student on the different kinds of propulsion for aircrafts and materials for gas turbine engines
5. To acquaint the student about space vehicles, re- entry, heat transfer and basics of satellite technology

COURSE CONTENT

UNIT I	INTRODUCTION TO FLIGHT	8

Brief history of Aviation-Hot air balloon and heavier than air flying machines-early airplane configurations-Modern Airplanes-Components of airplane and their functions-Rotary wing aircrafts-Space vehicles.

UNIT II	FUNDAMENTALS OF AERONAUTICS	11

International Standard Atmosphere-Pressure, Temperature and Density altitude, Basic Aerodynamics - Continuity, Momentum and Energy equations, Bernoulli's equation-Mach number-subsonic, transonic, sonic and supersonic flow regimes, Measurement of pressure and airspeed- IAS,EAS and TAS. Airfoil geometry and nomenclature-infinite and finite wing sections-lift, drag and moment coefficients-angle of attack-aspect ratio-Reynolds number-induced drag and parasite drag-airfoil characteristics, Elements of Aircraft performance, stability and control.

UNIT III	AIRCRAFT STRUCTURE AND MATERIALS	8

Structural components of an airplane- monocoque and semi monocoque structure –materials for structural components – composite materials and their significance in Aviation Technology

UNIT IV	AIRCRAFT PROPULSION	10

Propeller Engine – Gas Turbine Engine – Turbo prop, Turbo jet, Turbo fan Engines- specific fuel consumption-variation of thrust and power with speed and altitude – materials for engine components.

UNIT V	SPACE VEHICLES & ASTRONAUTICS	8

Basics of Rocket Technology-escape velocity-re entry vehicles-heat transfer problems of space vehicles-ablative cooling-Satellite technology– Hypersonic vehicles, Elements of Astronautics.

Text Books:

1. Anderson, J. D., Introduction to Flight,TataMcGraw-Hill Higher Education, 6th edition 2010.
2. Kermode, A. C, Barnard, R. H and Philpott, D. R, Mechanics of Flight, Pearson education, 2012.

References:

1. Shevell, R. C., Fundamentals of Flight., Prentice hall (2nd edition), 1989.
2. Steven, A. Brandt, Randall J. Stiles, John J. Bertin and Ray Whitford, Introduction to Aeronautics: A Design Perspective, AIAA Education series(2nd edition),2004.
3. Torenbeek, E and Wittenberg, H, Flight Physics:Essentials of Aeronautical Disciplines and Technology, with Historical Notes, Springer, 2009.
4. *https://books.google.co.in/books?isbn=1600860729*
5. *www.grc.nasa.gov/WWW/k-12/airplane/*

BAN302	FUNDAMENTALS OF FLUID MECHANICS	L	T	P	C
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Engineering Mechanics, Mathematics I & II				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To learn concepts of fluid, properties of fluid and its classification.
2. To understand fluid statics and dynamics.
3. Significance of similarity and model studies
4. To know about boundary layer concepts and its applications to pipe design.
5. To learn about pumps and turbine design.

COURSE CONTENT

UNIT I	INTRODUCTION	10

Fluid –definition-Fluid properties-Newton's law of viscosity-Classification of fluids-fluid statics-Hydrostatic forces on submerged surfaces- Stability of floating bodies

UNIT II	FLUID FLOW ANALYSIS AND FLOW MEASUREMENT	14

Ideal and real flow-Concept of continuum-Eulerian and Lagrangian approaches-Velocity field-Pathline, Streakline, Streamline- Stream tube- Fluid acceleration-Continuity, momentum differential equations-Navier Stokes equation- Stream function – Vorticity –Irrotationality- Potential function- Potential flow-Laplace equation-Bernoulli's equation and its applications-Venturimeter-Orifice meter , Flow Rate and Velocity Measurement.

UNIT III	DIMENSIONAL ANALYSIS	10

Buckingham Pi Theorem-Non dimensional numbers and their significance-Flow similarity and model studies.

UNIT IV	FLOW THROUGH PIPES	12

Laminar and turbulent flow- Boundary layer flow – Boundary layer thickness - Reynolds number and its significance-Laminar fully developed pipe flow-Hagen-Poiseuille flow-Coefficient of friction-Head loss – Darcy-Weisbach equation-Hydraulic gradient- Total energy lines-Moody's diagram-Turbulent flow through pipes.

UNIT V	FLUID MACHINERY	14
Classification of fluid machines-Reciprocating and centrifugal pumps-impulse and reaction turbines-Working principle of Pelton, Francis and Kaplan turbines-Velocity triangles-fans and blowers.		
Text Books: 1. Frank M White, Fluid Mechanics, The McGraw Hill companies. (7th edition), 2011. 2. Rathakrishnan, E, Fundamentals of Fluid Mechanics, Prentice-Hall (3rd edition), 2012.		
References: 1. Yunus A Cengel and John M Cimbala, Fluid mechanics: Fundamentals and Applications, Tata McGraw Hill (2nd edition), 2010. 2. Irving H Shames, Mechanics of Fluids, The McGraw Hill companies (4th edition), 2003. 3. Yuan, S.W, Foundations of Fluid Mechanics, Prentice-Hall, 1967. 4. *reu.eng.ua.edu › Programs* 5. *www.**fluidmechanics**.co.uk/*		

BAN303	FUNDAMENTALS OF AERO – THERMODYNAMICS	L	T	P	C
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Engineering Mechanics, Mathematics I & II				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce the concept of thermodynamic analysis that is central to many applications in engineering.
2. To acquaint the student with the basics of thermodynamic cycles.
3. To introduce a basic idea gas power cycles and vapor power cycles.
4. To develop the basic understanding of refrigeration and air-conditioning system.
5. To develop the basic understanding of aircraft propulsion system.

COURSE CONTENT

UNIT I	BASIC THERMODYNAMICS	16
Systems, Zeroth law, First law - Steady flow energy equation - Heat and work transfer in flow and non-flow processes - Second law, Kelvin-Planck statement - Clausius statement – Reversibility and irreversibility - Concept of Entropy, Clausius inequality, Principle of increase of entropy – Absolute entropy – Availability - Entropy change in non-flow processes		
UNIT II	**AIR POWER CYCLES**	**12**
Carnot, Otto, Diesel, Dual, Stirling and Ericsson cycle - Air standard efficiency – Mean effective pressure – Actual and theoretical PV diagram of two stroke and four stroke IC engines.		
UNIT III	**VAPOUR POWER CYCLES**	**12**
Introduction – Rankine cycle – Means of increase of efficiency of the Rankin cycle – Ideal reheat and regenerative Rankine cycle – Second law analysis of vapour power cycles – Cogeneration.		
UNIT IV	**REFRIGATION AND AIR – CONDITIONING**	**10**
Principles of refrigeration and Psychometric - Vapour compression - Vapour absorption types - Co-efficient of performance, Properties of refrigerants – Basic Principle and types of Air conditioning.		
UNIT V	**THERMODYNAMICS OF AIRCRAFT PROPULSION CYCLES**	**10**

Isentropic flow through passages – Brayton cycle – Brayton cycle with intercooling, reheat and regeneration – Ideal jet propulsion cycles. Basics of heat transfer.

Text Books:

1. Rathakrishnan E., Fundamentals of Engineering Thermodynamics, Prentice-Hall India, 2012.
2. Nag.P.K.,Engineering Thermodynamics, Tata McGraw-Hill, New Delhi, 2007.

Reference Books:

1. Yunus A Cengel and Michael A Boles., Thermodynamics- an Engineering approach, McGraw Hill Education (7^{th} edition), 2012.
2. Holman.J.P.,Thermodynamics, McGraw-Hill (3^{rd} edition), 2007.
3. Gordon J. Van Wylen and Richard E. Sonntag and Claus Borgnakke., Fundamentals of Classical Thermodynamics – Vol 1, Wiley Eastern, 1994.
4. Arora C.P., Thermodynamics, Tata McGraw-Hill, New Delhi, 2003.
5. Merle C Potter and Craig W Somerton., Thermodynamics for Engineers, Schaum's Outline Series, Tata McGraw-Hill (2^{nd} edition), 2009.
6. *www.thermocalc.com/*
7. *www.grc.nasa.gov/WWW/cdtb/**software**/t-mats.html*

BAN304	FUNDAMENTALS OF STRUCTURAL MECHANICS	L	T	P	C
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Engineering Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To provide the students an understanding on the linear statically determinate and indeterminate aircraft tension and compression problems and understanding the strength of materials
2. Introduce students the concept of energy methods for calculating strain energy in axial, torsion, bending and shear loadings.
3. To introduce the concept of buckling and lateral instability and calculation of buckling loads on columns.
4. To provide the design process using different theories of failures.
5. To impart knowledge on various induced stresses.

COURSE CONTENT

	REVIEW OF RIGID BODY MECHANICS	**2**
UNIT I	**INTRODUCTION TO STRENGTH OF MATERIALS**	**10**

Introduction to mechanics of deformable bodies - Material selection criteria – stress – strain – Stress and strain diagram - Hook's law - Elastic constants – definition of engineering constants: elastic modulus, Poisson's ratios, shear modules, relation between three modulus Poison's ratio, Young's modulus, shear modulus and bulk modulus. Statically determinate and indeterminate problems in tension and compression – Thermal stress – Impact loading – introduction to composite materials.

UNIT II	**THEORY OF ELASTICITY**	**12**

Concept of theory of elasticity – basic assumptions – Plane stress – Plane strain – Co-ordinate transformation – Stress tensor – Stress-strain dependence – General hooks law linear elastic and non-linear inelastic - Isotropic medium – Lam's constant – Miller indices – Strain from epitaxy – Introduction to thermal stress analogy.

UNIT III	BEAM THEORY	12

Shear force and bending moment diagrams for simply supported and cantilever beams – stress, strain and deflection in straight beams – flexural and shear stresses -Shear stress variation in beams of symmetric sections – Beams of uniform strength – Methods of evaluation of deflection.

UNIT IV	TORSION	12

Torsion of solid and hollow circular shafts – Shear stress variation – Power transmission in shafts – Open and closed-coiled helical springs – Stresses in helical springs.

UNIT V	BI – AXIAL STRESSES	12

Stresses in thin circular and spherical shell under internal pressure – Volumetric strain – Combined loading – Principle stresses and maximum shear stresses – Analytical and graphical methods - Mohr's circle.

Text Books:

1. Gere & Timoshenko, Mechanics of Materials, McGraw Hill, 1993
2. William Nash, Strength of Materials, Tata McGraw Hill, 2004

Reference Books:

1. F. P. Beer, E.R. Johnston, and J.T. Dewolf, Mechanics of Materials, McGraw-Hill (4^{th} edition), 2006
2.Dym,C.L., and Shames,I.H., Solid Mechanics, McGraw Hill, Kogakusha, 1973.
3. Stephen Timoshenko, Strength of Materials, Vol I & II, CBS Publishers and Distributors, Third Edition.
4. R.K.Rajput, Strength of Materials, S. Chand and Co., 1999.
5. Timoshenko,S. and Young,D.H., Elements of Strength of Materials, T.VanNostrand Co. Inc., Princeton, N.J., 1977.
6. *www.mdsolids.com/*
7. *https://www.actuspotentia.com/MechMat.shtml*

BAN305	MECHANICS OF MACHINES	L	T	P	C
	Total Contact Hours – 60	3	0	0	3
	Prerequisite – Engineering Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To impart students with the knowledge about motion, masses and forces in machines.
2. To enable students to apply fundamental of mechanics to machines which include engines, linkages etc.,
3. To impart students with the knowledge about various power transmitting devices such as gears, belts etc.
4. To facilitate students to understand the concept of balancing of rotating and reciprocating masses
5. To give awareness to students on the phenomenon of vibration and its effects

COURSE CONTENT

UNIT I	MECHANISMS	12
Machine Structure – Kinematic link, pair and chain – Grueblers criteria – Constrained motion – Degrees of freedom –Kutzbach criterion - Slider crank and crank rocker mechanisms – Inversions – Applications – Kinematic analysis of simple mechanisms – Determination of velocity and acceleration.		
UNIT II	**FRICTION**	**12**
Friction in screw and nut – Pivot and collar – Thrust bearing – Plate and disc clutches – Belt(Flat and Vee) and rope drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive.		
UNIT III	**GEARING AND CAMS**	**9**
Gear profile and geometry – Nomenclature of spur and helical gears – Gear trains: Simple,Compound gear trains and epicylic gear trains - Determination of speed and torque - Cams – Types of cams and followers.		
UNIT IV	**FORCE ANALYSIS AND BALANCING**	**15**
Introduction to force analysis - Static and dynamic – Inertia force and inertia torque – D'Alembert's principle -Static and dynamic balancing – Single and several masses in different planes –Balancing of reciprocating masses- primary balancing and concepts of secondary balancing – Single and multicylinder engines (Inline) – Balancing of radial V engine – direct and reverse crank method.		
UNIT V	**VIBRATION**	**12**
Free, forced and damped vibrations of single degree of freedom systems – Force transmitted to supports – Vibration isolation – Vibration absorption – Torsional vibration of shaft – Single and multi rotor systems – Geared shafts – Critical speed of shaft.		

Text Books:

1. Rattan.S.S., Theory of Machines, Tata McGraw–Hill Publishing Co, New Delhi, 2004.
2. Balaguru. S., Dynamics of Machinery, SciTech publication (2nd edition), 2009.

Reference Books:

1. Rao, J.S and Dukkipati, R.V, "Mechanism and Machine Theory", Second Edition, WileyEastern Ltd., 1992.
2. Malhotra, D.R and Gupta, H.C., "The Theory of Machines", SatyaPrakasam, Tech. IndiaPublications, 1989.
3. Gosh, A. and Mallick, A.K., "Theory of Machines and Mechanisms", Affiliated East West Press,1989.
4. Shigley, J.E. and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw-Hill, 1980.
5. Burton Paul, "Kinematics and Dynamic of Planer Machinery", Prentice Hall, 1979.
6. *ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5593596*
7. *www.simple**machines**.org/*

BAN3L1	FLUID MECHANICS AND MACHINERIES LAB	L	T	P	C
	Total Contact Hours – 45	0	0	3	2
	Prerequisite – Engineering Mechanics				
	Course Designed by – Department of Civil Engineering				

OBJECTIVES

1. To help the student to understand about pipe flow losses and flow through notches and weirs.
2. To accustom the student about buoyancy test and Bernoulli's principle
3. To introduce to the student about the various flow meters
4. To acquaint the student about the performance characteristics of various pumps
5. To introduce to the student about the performance characteristics of various turbines

LIST OF EXPERIMENTS	
1	Determination of pipe flow losses.
2	Calibration of orifice meter and venture meter.
3	Flow through notches and weir.
4	Flow through open orifice
5	Buoyancy experiment – Metacentric Height.
6	Verification of Bernoulli's Equation.
7	Performance characteristics of centrifugal pump.
8	Performance characteristics of submergible pump.
9	Performance characteristics of jet pump.
10	Performance characteristics of oil gear pump.
11	Characteristics of impulse turbine – Pelton wheel turbine.
12	Characteristics of reaction turbine – Francis turbine

References:

1. Fluid Mechanics and Machinery Lab Manual, Department of Civil Engineering, 2015

	STRENGTH OF MATERIALS LAB	L	T	P	C
BAN3L2	Total Contact Hours – 45	0	0	3	2
	Prerequisite – Engineering Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To enable the student to understand about the tensile test and stress – strain curves and also about the compression tests
2. To accustom the student about shear test, torsion test and hardness tests.
3. To introduce to the student about the impact test.
4. To acquaint the student about the open and closed coil spring tests.
5. To introduce to the student about fatigue test.

LIST OF EXPERIMENTS	
1	Tension test of a mild steel rod.
2	Shear test on mild steel and aluminum rod.
3	Torsion test on mild steel rod.
4	Hardness test (a) Brinell& (b) Rockwell.
5	Impact tests (a) Izod (b) Charpy.
6	Deflection test on helical spring.
7	Fatigue test: (a) Reverse plate bending (b) Rotating beam.
8	Block compression test.

References:

1. Strength of Materials Lab Manual, Department of Aeronautical Engineering, 2015

BME3L1	MACHINE DRAWING	L	T	P	C
	Total Contact Hours – 45	0	0	3	2
	Prerequisite – Engineering Graphics				
	Course Designed by – Department of Mechanical Engineering				

OBJECTIVES

1. To give the students an idea of fundamental issues common to almost all areas of machine drawing.
2. To train the student to draw an assembled diagram of a machine part based on the details of individual parts.
3. To help the student to understand the machine drawing, nomenclature and various notations.
4. To train the students to prepare a working drawing of machines.
5. To enable the student to communicate his ideas through drawings.

COURSE CONTENT

- Indian standard code (BIS) of practice for engineering drawing – general principle of presentation, conventional representation of threaded parts, springs, Gears and common features, Abbreviations and symbols used in technical drawings.
- Tolerance – Types – Symbols used and representation on the drawing – fit types, selection for different application – Allowance, Interchangeability. Surface finish Relation to the manufacturing processes – Types of representation on the drawing welding symbols.
- Preparation of working drawing for given machine components: Bolts, Screws, Studs, Nuts, Keys and Key-ways.
- Preparation of simple assembly drawings: Different types of cotter and knuckle joints.
- Preparation of simple assembly drawing for following machine with part drawings given: Screw jack, Plummer block, connecting rod, machine vice, tail stock of lath, fuel injection pump for single cylinder engine, stop valve.

Text Books:
1. Narayanan. K. L. Machine Drawing, New age publisher, 2006.

References:
1. Bhatt, N. D.., Machine Drawing, Charotar publishing house, 2000.
2. Gopala Krishnan, Machine Drawing, Subash publishers, 2001.
3. *https://www.smartdraw.com/software/mechanical-drawing-software.htm*
4. *https://www.**machine**designonline.com/*

BMA402	NUMERICAL METHODS	L	T	P	C
	Total Contact Hours – 75	3	2	0	4
	Prerequisite – Mathematics III, Engineering Physics, Engineering Mechanics				
	Course Designed by – Department of Mathematics				

OBJECTIVES
1. To introduce the solution of equations and Eigen value problems.
2. To acquaint the student with interpolation techniques used in wide variety of situations.
3. To introduce the effective mathematical tools for the solutions of numerical differentiation and integration.
4. To develop the initial value problems for ordinary differential equations.
5. To develop the boundary value problems for ODE and PDE.

COURSE CONTENT

UNIT I	**INTERPOLATION (FINITE DIFFERENCES)**	**9+6**
Iterative method, Newtown-Raphson method for single variable-solutions of linear system by Gaussian, Gauss-Jordan, Jacobian and Gauss-Siedel methods, Inverse of matrix by Gauss-Jordan method , Eigen value of a matrix power and Jacobian methods.		
UNIT II	**INTERPOLATION (FINITE DIFFERENCES)**	**9+6**
Newton's Divided difference formula, Lagrange's interpolation-forward and backward difference formula-Stirling's and Bessel's central difference formula.		
UNIT III	**NUMERICAL DIFFERENTIATION AND INTEGRATION**	**9+6**
Numerical differentiation with interpolation polynomials, Numerical integration by Trapezoidal Simpson's 1/3" and 3/8" rule, Double integrals using Trapezoidal and Simpson's rule.		
UNIT IV	**INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS**	**9+6**
Single step methods, Taylor series, Euler and modified Euler, Rungekutta method of first and second order differential equations, multiple step methods, Milne and Adam's – Bash forth predictor and corrector method.		
UNIT V	**BOUNDARY VALUE PROBLEMS FOR ODE AND PDE**	**9+6**
Finite difference for the second order ordinary differential equations, finite difference solutions for one dimensional heat equations (both implicit and explicit), one dimensional wave equation, Two dimensional, Laplace and Poisson equation.		

Text Books:

1. Jain. M. K. Iyengar, S. R. K. And Jain, R K., Numerical Methods for Scientific and Engineering Computation, 3rd edition, New age international publication, company, 1993
2. Grewal, B.S., Higher Engineering Mathematics, Khanna Publications, 2007.

References:

1. M. K. Venkatraman., Numerical Methods, NPC, Chennai.
2. Richard W. Hamming., Numerical Methods for Scientists and Engineers, Dover Publications (2nd edition), 1987.
3. *https://www.wolfram.com/**mathematica**/*

BAN401	**AIRCRAFT STRUCTURES I**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Engineering Mechanics, Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint students with the fundamentals of aircraft structures.
2. To acquaint students with statically determinate and indeterminate structures.
3. To introduce students to energy methods applied to simple aerospace structural elements.
4. To introduce various structural analysis of various column type aerospace structural elements.
5. To introduce various failure theory of structural analysis.

COURSE CONTENT

UNIT I	**TRUSSES AND FRAMES**	**12**

Statically determinate frames - Analysis of plane Truss - Method of joints - 3 D Truss- Plane frames - Composite beam.

UNIT II	**STATICALLY DETERMINATE AND INDETERMINATE STRUCTURES**	**12**

Propped Cantilever - Fixed-Fixed beams - Clapeyron's Three Moment Equation – slope deflection and energy distribution method.

UNIT III	**ENERGY METHODS**	**12**

Strain energy evaluation in structural members – energy theorems – dummy load & unit load methods – Maxwell's reciprocal theorem – energy methods applied to statically determinate and indeterminate beams, frames, rings & trusses

UNIT IV	**COLUMNS**	**12**

Euler's column curve – inelastic buckling – effect of initial curvature – the Southwell plot – columns with eccentricity – use of energy methods – theory of beam columns – beam columns with different end conditions – stresses in beam columns.

UNIT V	**FAILURE THEORY**	**12**

Fail safe and safe life structures, factor of safety, Brief introduction of yield material, brittle vs. ductile behavior, Creep and creep rupture, viscoelastic materials - environmental stress, stress potentials, effect of time and temperature - Fatigue and Fracture - Maximum Stress theory –

Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.
Text Books: 1. Donaldson, B.K., Analysis of Aircraft Structures – An Introduction, McGraw-Hill,1993. 2. Megson T M G, Aircraft Structures for Engineering Students, Edward Arnold Publishers 3. C.T.Sun, Mechanics of aircraft structures, John wiley& sons, inc.
References: 1. Timoshenko, S., Strength of Materials, Vol. I and II, Princeton D. Von Nostrand Co, 1990. 2. Peer, D. J., and Azar J. J., Aircraft Structures, McGraw – Hill (2nd edition), 1999. 3. Bruhn.E.F., Analysis and design of flight vehicle structures, Tri set of offset company, 1973. 4. Michael C.Y.Niu ,Airframe structural design (ISBN No.962-7128-04-X), 1998 5. Rivello,Theory and Analysis of Flight Structures, McGraw-Hill, 1969. 6. Perry, Aircraft Structures, McGraw-Hill, 1950.

BAN402	**AERODYNAMICS I**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Engineering Mechanics, Mathematics I, II & III, Fundamentals of Fluid Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce student about basic concepts of mathematical formulation of air flow.
2. To impart theoretical knowledge about the elementary flow and their combination to analysis flow over real object.
3. To Study the distribution of pressure around airfoil for incompressible inviscid flow. To study transformation of flow over circle cylinder into flow over the airfoil
4. To study flow around wing and measure lift generated.
5. To introduce the students about viscous flow theory for flow over flat and solution for incompressible viscous flow over flat plate.

COURSE CONTENT

UNIT I	**BASIC AERODYNAMIC PRINCIPLES**	**12**

Models of fluid - System and Control volume approach, substantial, local and convective derivative, Continuity, momentum and energy equations, Inviscid flow, Euler equation, incompressible Bernoulli's Equation. Circulation and Vorticity, Green's Lemma and Stoke's Theorem, Barotropic Flow, Kelvin's theorem, Streamline, Stream Function, Irrotational flow, Potential Function, Equipotential Lines, Elementary Flows and their combinations.

UNIT II	**FUNDAMENTALS OF INVISCID FLOWS**	**12**

Ideal Flow over a circular cylinder, D'Alembert's Paradox, Magnus effect, KuttaJoukowski Theorem, Starting Vortex, Kutta condition, Real flow over smooth and rough cylinder, Basics of vortex theory, Basics of compressible flow.

UNIT III	**AIRFOIL THEORY**	**12**

Cauchy-Riemann relations, Complex Potential, Methodology of Conformal Transformation, Kutta-Joukowski transformation and its applications, Karman Trefftz Profiles, Thin Airfoil theory and its applications.

UNIT IV	FINITE WING THEORY	12

Vortex Filament, Biot and Savart Law, Bound Vortex and trailing Vortex, Horse Shoe Vortex, Lifting Line Theory and its limitations, induced drag coefficient, elliptic and general lift distribution, Oswald's wing efficiency factor, effect of plan form and aspect ratio

UNIT V	VISCOUS FLOW THEORY	12

Laminar Boundary layer and its thickness, displacement thickness, momentum thickness, Energy thickness, Shape parameter, Boundary layer equations for a steady two dimensional incompressible flow, Boundary Layer growth over a Flat plate, Critical Reynolds Number, Blasius solution, Basics of Turbulent flow, Prandtl's mixing length hypothesis, Free shear layers.

Text Books:

1. Anderson, J.D., Fundamentals of Aerodynamics, McGraw Hill Book Co., 1999, Indian Edition
2. Rathakrishnan, E., Theoretical Aerodynamics, John Wiley & Sons, Inc., 2013

References:

1. Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985
2. John J Bertin., Aerodynamics for Engineers, Pearson Education Inc, 5th Edition.
3. Clancy L J., Aerodynamics, John Wiley & sons, 1991.

BAN403	AIRCRAFT PROPULSION	L	T	P	C
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Engineering Mechanics, Fundamentals of Aero – Thermodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To provide students with an overview of various aerospace propulsion systems.
2. To provide students with a sound foundation in the fundamentals of thermodynamics of aircraft engines
3. To teach students the elementary principles of inlets and nozzle
4. To teach students basic principles of compressors and turbines used in aircraft propulsion
5. To teach students about the various type of combustion chamber and combustion process

COURSE CONTENT

UNIT I	FUNDAMENTALS OF ENGINES	10

History and classifications of Aero engines, Working of gas turbine engine – Thrust equation – Factors affecting thrust – Engine performance parameters – Efficiency, Specific fuel consumption, Methods of thrust augmentation – Characteristics of propeller, turboprop, turbofan and turbojet engines.

UNIT II	INLETS AND NOZZLES	14

Subsonic inlets– External and internal flow pattern – inlet performance criterion –Boundary layer separation – Supersonic inlets – the starting problem – shock boundary layer problem – external deceleration – flow stability problem – Exhaust nozzles –Theory of flow in isentropic nozzles – Losses in nozzles –Nozzle efficiency—nozzle choking –Over expanded and under expanded nozzles – Ejector and variable area nozzles – Interaction of nozzle flow with adjacent surfaces – Thrust reversal

UNIT III	COMPRESSORS	14
Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations – Concept of pre whirl – Rotation stall – Elementary theory of axial flow compressor – Velocity triangles – degree of reaction – Three dimensional – Air angle distributions for free vortex and constant reaction designs – Compressor blade design – Centrifugal and Axial compressor performance characteristics.		
UNIT IV	**COMBUSTION CHAMBERS**	**12**
Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – flame holders.		
UNIT V	**TURBINES**	**10**
Elementary theory of axial flow turbine – Vortex theory – Stator and rotor blades – losses in the blade – choice of blade profile, chord and pitch – stage and overall performance – blade cooling – radial flow turbine.		

Text Books:

1. Hill, P.G. & Peterson, C.R, Mechanics & Thermodynamics of Propulsion, Addison – Wesley Longman INC, 1999.
2. Cohen, H. Rogers, G.F.C. and SaravanaMuttoo, H.I.H., Gas Turbine Theory, Longman, 1989.

References:

1. Ahmed F. El-Sayed, Aircraft Propulsion and Gas turbine engines, CRS Press, 2008
2. Saeed Farokhi, Aircraft Propulsion, John Wiley & Sons, Inc ., 2009
3. Rolls Royce Jet Engine – 5thEdition – 1996.
4. Oates, G.C., Aero thermodynamics of Aircraft Engine Components, AIAA Education Series.

BAN404	AIRCRAFT SYSTEMS AND INSTRUMENTATION	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Aeronautics and Astronautics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with the various aircraft systems
2. To introduce to the student about the different control systems in aircrafts
3. To familiarize the student to the different systems associated with aircraft engines
4. To acquaint the student to the several auxiliary systems in aircrafts
5. To enable the student to understand about the working of basic aircraft instruments

COURSE CONTENT

UNIT I	AIRCRAFT SYSTEMS	12
Hydraulic systems - Study of typical workable system - components –Hydraulic systems controllers – Pneumatic systems - Advantages - Working principles - Typical Air pressure system – Brake system- Typical Pneumatic power system - Components, Landing Gear systems – Classification.		
UNIT II	**AIRPLANE CONTROL SYSTEMS**	**10**
Conventional Systems - fully powered flight controls - Power actuated systems – Modern control systems		

- Digital fly by wire systems - Auto pilot system active control Technology.		
UNIT III	**ENGINE SYSTEMS**	**8**
Fuel systems for Piston and jet engines, - Components of multi engines. Lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.		
UNIT IV	**AUXILIARY SYSTEMS**	**8**
Basic Air cycle systems - Vapour Cycle systems, Evaporative vapour cycle systems -Evaporative air cycle systems –Oxygen systems - Fire protection systems, Deicing and anti icing systems.		
UNIT V	**AIRCRAFT INSTRUMENTS**	**7**
Flight Instruments and Navigation Instruments – Gyroscope - Accelerometers, Air speed Indicators – TAS, EAS- Mach Meters - Altimeters - Principles and operation - Study of various types of engine instruments - Tachometers - Temperature gauges – Pressure gauges - Operation and Principles.		

Text Books:

1. McKinley, J.L., and Bent, R.D., Aircraft Maintenance & Repair, McGraw-Hill,1993.
2. General Hand Books of Airframe and Powerplant Mechanics, U.S. Dept. ofTransportation, Federal Aviation Administration, The English Book Store, NewDelhi1995.

References:

1. Mekinley, J.L. and Bent, R.D., Aircraft Power Plants, McGraw-Hill, 1993.
2. Pallet, E.H.J., Aircraft Instruments & Principles, Pitman & Co., 1993.
3. Treager, S., Gas Turbine Technology, McGraw-Hill, 1997.

BCE406	**ENVIRONMENTAL STUDIES**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Engineering Chemistry, Biology for Engineers				
	Course Designed by – Department of Humanities and Sciences				

OBJECTIVES

1. To acquaint the student about the various natural resources and their associated problems
2. To accustom the student about ecosystem and the different types of ecosystems and their importance
3. To introduce to the student about the values of bio diversity and the importance of its conservation and also on environmental pollution
4. To familiarize the student on the social issues that have a direct effect on the environment
5. To help the student understand about the effects of human population on the environment and remedial measures

COURSE CONTENT

UNIT I	**THE MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES**	**9**

Definition, scope and importance, Need for public awareness.

Natural Resources : Renewable And Non – Renewable Resources

Natural resources and associated problems

a) Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effect on forests and tribal people.
b) Water resources : Use and over-utilization of surface and ground water, flood, drought conflicts over water, dams-benefits and problems.

c) Mineral resources : Uses and exploitation, environmental effects of extracting and using mineral resources, case studies.
d) Food resources : World food problems, changes caused by agriculture and overgrazing , effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources, case studies.
f) Land resources : Land as a resource, Land degradation, man induced landslides, soil erosion and desertification

Role of an individual in conversation of natural resources, Equitable use of resources for sustainable lifestyles.

UNIT II	ECOSYSTEMS	8

Concepts of an ecosystem. Structure and function of an ecosystem, producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids - Introduction, types, characteristic features, structure and function of the following ecosystem :- Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, (ponds, streams, lakes, rivers, oceans, estuaries)-

Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation - Ethics : Issues and possible Solutions, Climate change, global warming, acid rain, ozone layer depletion.

UNIT III	BIODIVERSITY AND ENVIRONMENTAL POLLUTION	14

BIODIVERSITY

Introduction and Definition - genetic, species and ecosystems diversity, Biogeographical classification of India - Value biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values - Biodiversity at global, national and local levels. India as a mega-diversity nation, Hot-spots of biodiversity -Threats to biodiversity, habitat, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation biodiversity - In-situ and Ex-situ conservation of biodiversity.

ENVIRONMENTAL POLLUTION

Definition, Causes, effects and control measures of ;- Air Pollution, Water pollution, Soil Pollution, Marine Pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management : Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Pollution case studies - Disaster Management : floods earthquake, cyclone and landslides.

UNIT IV	SOCIAL ISSUES AND THE ENVIRONMENT	8

From Unsustainable to Sustainable development, Urban problems related to energy, nuclear accident and holocaust, case studies, wasteland reclamation, Environmental Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife protection Act, Forest Conservation Act, Issues involved in enforcement of environmental Legislation, public awareness –

Fireworks and its impact on the Environment – Chemicals used in Fireworks – (Fuel –oxidizing Agent – Reducing Agent –Toxic Materials – Fuel –Binder- Regulator) – Harmful nature of ingredients – chemical effects on health due to inhaling fumes – Noise produced by fire crackers – Noise pollution – Noise level standards for fire crackers – Intensity of sound – Impact on hearing – Safety measures.

UNIT V	HUMAN POPULATION AND THE ENVIRONMENT	6

Population growth, variation among nations, population explosion-Family Welfare programs, Environment and human health, Human Rights, Value Education, HIV and AIDS, Women and Child Welfare, Role of Information Technology in Environment and Human health - Case Studies

Text Books:
1. Gilbert M.Masters, "Introduction to Environmental Engineering and Science", Pearson Education Pvt., Ltd., Second Edition, ISBN 81-297-0277-0, 2004.
2. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
3. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.,Ahmedabad – 380 013, India, 1989.
4. Benny Joseph, "Environmental Studies"., TATA McGraw Hill, 2010

References:
1. Trivedi R.K., "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol.I and II, EnviroMedia 2009
2. Cunningham, W.P.Cooper, T.H.Gorhani, "Environmental Encyclopedia", Jaico Publ., House, Mumbai, 2001.
3. Wager K.D. "Environmental Management", W.B. Saunders Co., Philadelphia, USA, 1998.
4. Trivedi R.K. and P.K. Goel, "Introduction to Air Pollution", Techno Science Publications 2013
5. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB),2001.
6. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
7. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
8. Jadhav, H &Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
9. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
10. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
11. Rao M N. &Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publish Co. Pvt. Ltd. 345p.
12. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut.
13. http://eng.mft.info/uploadedfiles/gfiles/c8e31c9e52d84c3.pdf

BAN4L1	AIRCRAFT STRUCTURES LABORATORY	L	T	P	C
	Total Contact Hours – 45	0	0	3	2
	Prerequisite – Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student to the various experimental processes to carry out structural analysis.
2. To familiarize to the student about the analysis of beams.
3. To enable the student to understand about the analysis of columns.
4. To help the student to understand about the effect of complex loading on aircraft structures.
5. To introduce to the student about the shear flow estimation in aircraft structures.

LIST OF EXPERIMENTS

1	Determination of Young's modulus of aluminum using electrical extensometers.
2	Determination of fracture strength and fracture pattern of ductile material.
3	Deflection of beams with various end conditions.
4	Verification of Maxwell's theorem and principle of superposition.
5	Column – Testing.

6	Testing of riveted joints.
7	Unsymmetrical Bending of a Beam
8	Determination of Shear Centre in open Section
9	Determination of Shear Centre in closed Section
10	Combined bending and Torsion of a Hollow Circular Tube
11	Constant Strength Beams
12	Wagner beam – Tension field beam
13	Free Vibration of a beams
14	Forced Vibration of a beams
15	Material properties test of composite laminate

References:

1. Aircraft Structures Lab Manual, Department of Aeronautical Engineering, 2015

BAN4L2	**MANUFACTURING ENGINEERING LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Manufacturing Engineering				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce student to various machine cutting operation
2. To train the student for using the lathe
3. To train the student for performing various operation using lathe
4. To train the student for performing drilling operations and boring operation
5. To train the student for using the surface grinding machine and milling machine

LIST OF EXPERIMENTS

1	Study of centre, capstan and automatic lathes and their accessories.
2	Exercise on setting the work piece and the tool in the lathe.
3	Plane turning and step turning.
4	Taper turning and knurling.
5	Eccentric Turning.
6	Thread cutting and grooving.

7	Drilling and reaming.
8	Drilling and boring.
9	Surface grinding
10	Study of shaper and planer machines.
11	Study of milling and grinding machines.

References:

1. Machine Shop Lab Manual, Department of Mechanical Engineering, 2015

BAN4S1	**COMPUTER AIDED DESIGNING AND DRAFTING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Engineering Graphics, Machine Drawing				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with various computer softwares for engineering design
2. To familiarize the student with to the various options and types of designs that can be carried out using CATIA software
3. To train the student on the designing of basic mechanical parts
4. To train the student on the assembly of different mechanical parts
5. To train the student on the drafting of the part / model / assembly designed.

LIST OF EXPERIMENTS

1	Study of various softwares for engineering design and drafting
2	Study of CATIA and its tools
3	Exercise on 2D drawing
4	Exercise on pad and groove
5	Exercise on shaft, mirror and array
6	Exercise on threading, bores and tappings
7	Exercise on part assembly
8	Exercise on drafting
9	Exercise on surface modeling
10	Exercise on kinematics

References:

1. CADD Lab Manual, Department of Aeronautical Engineering, 2015

BAN501	AIRCRAFT STRUCTURES II	L	T	P	C
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Fundamentals of Structural Mechanics, Aircraft Structures I				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To understand the basic concepts of Aircraft structural Mechanics in Aeronautical engineering and society. Understand the basics of unsymmetrical bending loadings and the parameters and know how to use them in real problems.
2. Understand the basic concept of shear flow in open sections and know how to use it to solve engineering problems and understand shear flow in closed sections and know how to use them to solve engineering problems.
3. Understand the buckling of plates and using the concepts to solve the sheet panel problems.
4. Understand the basics of stress analysis in wing and fuselage and to develop the skill to solve fundamental engineering problem.
5. Overall improvement in subject knowledge in Aircraft Structures.

COURSE CONTENT

UNIT I	UNSYMMETRICAL BENDING	12

Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetrical sections – generalized ‘k’ method, neutral axis method, principal axis method- advantages and disadvantages.

UNIT II	SHEAR FLOW IN OPEN SECTIONS	12

Thin walled beams – concept of shear flow – the shear centre and its determination – shear flow distribution in symmetrical and unsymmetrical thin-walled sections – structural idealization – shear flow variation in idealized sections.

UNIT III	SHEAR FLOW IN CLOSED SECTIONS	12

Bredt - Batho theory – single-cell and multi-cell tubes subject to torsion – shear flow distribution in thin-walled single & multi-cell structures subject to combined bending torsion – with walls effective and ineffective in bending – shear center of closed sections.

UNIT IV	BUCKLING OF PLATES	12

Bending of thin plates – rectangular sheets under compression - local buckling stress of thin walled sections – crippling strength by Needham’s and Gerard’s methods – thin-walled column strength – load carrying capacity of sheet stiffener panels – effective width – inter-rivet and sheet wrinkling failures - short panel failing strength.

UNIT V	STRESS ANALYSIS OF WING AND FUSELAGE	12

Wing structural arrangements – factors influencing - wing stress analysis methods – determination of shear force and bending moment distribution over fuselage – Numerical problems – Tension field beam – general Wagner equation - Semi-tension field beams.

Text Books:

1. Megson T M G , ‘Aircraft Structures for Engineering Students’, Fifth Edition, Elsevier Aerospace Engineering Series,2007.
2. Howard D Curtis, ‘Fundamentals of Aircraft Structural Analysis’, WCB-McGraw Hill, 1997

References:
1. Rivello, R.M., Theory and Analysis of Flight Structures, McGraw Hill, 1993.
2.Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999
3. Bruhn. E.H., 'Analysis and Design of Flight Vehicles Structures', Tri-state off-set company, USA, 1985

BAN502	AERODYNAMICS II	L	T	P	C
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Fundamentals of Fluid Mechanics, Aerodynamics I				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To make the student understand concepts and 1-d equations used for compressible flows.
2. To acquaint the student with the estimation of flow properties across normal shock, oblique shock and expansion waves.
3. To familiarize the student to the governing equations in compressible flows.
4. To educate the student on problems faced by high speed flow airfoils, wings and airplane configuration and to understand design modifications required to overcome problems..
5. To create awareness among the students about various experimental methods and measurement techniques.

COURSE CONTENT

UNIT I	FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW	12

Compressibility, Continuity, Momentum and Energy equation for steady one dimensional flow, Compressible Bernoulli's equation, Area – Mach number – Velocity relation, Mach cone, Mach angle, One dimensional Isentropic flow through variable area duct, Isentropic relations - Critical conditions, Characteristic Mach number, Maximum discharge velocity.

UNIT II	SHOCKS AND EXPANSION WAVES	12

Normal shock relations, Prandtl's relation, Hugonoit equation, Raleigh Supersonic Pitot tube equation, Moving normal shock waves, Oblique shocks, θβM relation, Shock Polar, Reflection of oblique shocks, Left running and Right running waves, Interaction of oblique shock waves, slip line, Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simple and non-simple regions, Operating characteristics of convergent and convergent-divergent nozzles.

UNIT III	TWO DIMENSIONAL COMPRESSIBLE FLOW	12

Potential equation for 2-dimensional compressible flow, Linearization of potential equation,Small perturbation theory, Linearised Pressure Coefficient, Linearised subsonic flow, Prandtl-Glauert rule, Linearised supersonic flow, Method of characteristics, Wave drag coefficient.

UNIT IV	HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION	12

Critical Mach number, Drag divergence Mach number, Shock Stall, Shock- Boundary layer interaction, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock-expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircrafts, Introduction to Hypersonic Flows, Numerical Analysis of one Dimensional flow.

UNIT V	EXPERIMENTAL METHODS	12
Wind tunnels for Subsonic, transonic, Supersonic and hypersonic flows, Various Measurement techniques, Power requirement, Force and moment measurement, Wind tunnel balance, Wind tunnel corrections, Flow visualization techniques, Hot wire technique, Optical methods, Shock tube, Gun tunnels		

Text Books:

1. Anderson, J. D, Modern Compressible Flow, Third Edition, Tata McGraw-Hill & Co., 2012.
2. Rathakrishnan., E, Gas Dynamics, Prentice Hall of India, 2004.
3. Yahya S.M., Fundamentals of Compressible Flows, Third Edition, New Age International Publishers, 2003.

References:

1. Shapiro, A. H., Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982.
2. Zucrow, M. J. and Anderson, J. D., Elements of Gas Dynamics, McGraw- Hill & Co., 1989.
3. Oosthuizen,P.H., &Carscallen,W.E., Compressible Fluid Flow, McGraw- Hill & Co., 19976. Perry, Aircraft Structures, McGraw-Hill, 1950.

BAN503	ADVANCED AEROSPACE PROPULSION	L	T	P	C
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Fundamentals of Aero – Thermodynamics, Aircraft Propulsion				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student about the various scramjet and ramjet engine propulsion.
2. To accustom the student about pulsejet propulsion and the different types of jet propulsion their importance.
3. To introduce to the student about the importance of solid propellant rockets.
4. To introduce to the student about the importance of liquid propellant rockets.
5. To help the student understand about the non conventional propulsion techniques.

COURSE CONTENT

UNIT I	RAMJET AND SCRAMJET PROPULSION	14
Operating principle of ramjet engine – Components of ramjet engines and their efficiencies – Combustion in ramjet engine – Critical, subcritical and supercritical modes of operation -Ramjet engine and its performance characteristics – Ramjet design calculations – Flame stability problems in ramjet combustors –Integral ram rockets. - Introduction to hypersonic vehicles and supersonic combustion - problems associated with supersonic combustion– Various types scramjet combustors – Fuel injection schemes in scramjet combustors – one dimensional models for supersonic combustion using method of influence coefficient.		

UNIT II	PULSEJET PROPULSION	10
Pulse propulsion – Combustion process in pulse jet engines – inlet charging process – Supercritical charging and subcritical discharging – Subcritical charging and subcritical discharging – Subcritical charging and supercritical discharging.		

UNIT III	SOLID PROPELLANT ROCKETS	12

Operating principle – Specific impulse of a rocket – Internal ballistics – Selection criteria of solid propellants – propellant grain design considerations – Progressive, Regressive and neutral burning in solid rockets.		
UNIT IV	**LIQUID PROPELLANT ROCKETS**	**12**
V Liquid propellant rockets – selection of liquid propellants – various feed systems for liquid rockets – cryogenic techniques - Thrust vector control – Cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets - introduction to hybrid propulsion – advantages and limitations of hybrid propulsion - static testing of rockets and safety considerations.		
UNIT V	**NON - CONVENTIONAL PROPULSION TECHNIQUES**	**12**
Introduction to nozzleless propulsion and basic concepts - Electric rocket propulsion – Plasma as a fluid- Diffusion in Partially Ionized gases - Ion propulsion – Nuclear rocket – Types – Solar Sail - comparison of performance of these propulsion systems with chemical rocket propulsion systems.		
Text Books: 1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 8th Edition, 2010. 2. Thomas A Ward, "Aerospace Propulsion Systems", John Wiley & Sons Inc., New York,2010.		
References: 1. J D Mattingly, "Elements of Propulsion - Gas Turbines and Rockets ", AIAA Education Series, 2006. 2. David H. Heiser and David T. Pratt., "Hypersonic Air -breathing Propulsion", AIAA Education Series, 1999. 3. DanM.Goebel, Ira Katz, 'Fundamentals of Electric Propulsion', John Wiley & Sons Inc, New York, 2003.		

BAN504	**FLIGHT MECHANICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Fundamentals of Aeronautics and Astronautics, Aerodynamics I				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To understand aircraft performance relating to steady level
2. To understand aircraft performance relating to Range, Endurance, climb & Glide
3. To acquire knowledge about Take off, Landing and Turning performance
4. To understand the principles of stability and control relating to longitudinal stability
5. To understand the principles of stability and control relating to directional and lateral stability

COURSE CONTENT

UNIT I	**STEADY LEVEL FLIGHT**	**12**
International Standard Atmosphere, TAS, IAS and EAS, Streamlined and Bluff body – Skin friction Drag, Pressure Drag and Induced Drag – Drag Polar – Various drags of an airplane – Methods of Drag Reduction - Effect on Drag Polar. Steady level flight, Thrust required and Power required, Thrust available and Power available for propeller driven and jet powered aircraft, Effect of altitude, conditions for minimum drag and minimum power required		
UNIT II	**RANGE, ENDURANCE, CLIMB AND GLIDE PERFORMANCE**	**12**

Range and Endurance of Propeller and Jet aircrafts, Shallow and steep angles of climb, Rate of climb, Climb hodograph, Maximum Climb angle and Maximum Rate of climb- Effect of design parameters for propeller and jet aircrafts, Absolute and service ceiling, Cruise climb, Gliding flight, Glide hodograph

UNIT III	TAKE OFF, LANDING AND TURNING PERFORMANCE	10

Take-off and landing performance, Turning performance, bank angle and load factor, Constraints on load factor, Pull up and pull down maneuvers, maximum turn rate, V-n diagram.

UNIT IV	LONGITUDINAL STABILITY	14

General concepts, Static and dynamic stability, Stability and Controllability, Requirements of control surfaces, criteria for longitudinal static stability, contribution to stability by wing, tail, fuselage, wing fuselage combination, Total longitudinal stability, Neutral point-Stick fixed and Stick free aspects, Free elevator factor, static margin, Hinge moment, Power effects on stability-propeller and jet aircrafts, longitudinal control, Movement of centre of gravity, elevator control power, elevator angle to trim, elevator angle per g, maneuver point, Stick force gradient and stick force per g, Aerodynamic balancing

Aircraft Equations of motion, small disturbance theory, Estimation of longitudinal stability derivatives Routh's discriminant, solving the stability quartic, Phugoid motion, Factors affecting the period and damping.

UNIT V	LATERAL AND DIRECTIONAL STABILITY	12

Directional stability-yaw and sideslip, contribution to static directional stability by wing, fuselage, vertical tail, Power effects on directional stability-propeller and jet aircrafts, Rudder lock and Dorsal fin, Directional control, rudder control power, rudder requirements, adverse yaw, asymmetric power condition, spin recovery, Lateral stability-Dihedral effect, contribution of various components, lateral control, aileron control power, strip theory, roll control by spoilers, aileron reversal, aileron reversal speed

Text Books:

1. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International Edition, 2012.
2. Houghton,E.L. and Carruthers, N.B. Aerodynamics for engineering students, Edward Amold Publishers, 2000

References:

1. Nelson, R.C." Flight Stability & Automatic Control", McGraw Hill, 2005.
2.Pamadi, B.N. Performance, Stability, Dynamics, and Control of Airplanes, AIAA Education Series, 2004
3. McCormick, B.W. "Aerodynamics, Aeronautics & Flight Mechanics", John Wiley, 1995.
4. Babister, A.W. "Aircraft Stability and response", Pergamon Press, 1996.
5.Etkin, B., "Dynamics of Flight Stability and Control", John Wiley, New York, 1982.
6. Perkins C.D. &Hage R.E. "Airplane performance, stability and control", John Wiley & Sons 1976.

BAN505	MANUFACTURING ENGINEERING	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite –Engineering mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce student about various metal working process
2. To impart theoretical knowledge about the metal cutting and machining process.
3. Introduce students about various special purpose machine and milling machine.
4. Introducing students about various drilling, boring and surface finish operations.
5. Introduce students about various non conventional process and high energy rate forming process.

COURSE CONTENT

UNIT I	**METAL WORKING PROCESS**	**8**

Mechanical working of metals –hot and cold working –rolling, extrusion, spinning, wire-drawing, press working. Welding – different types of gas and arc welding process, soldering and brazing. Casting –different types, furnaces, casting defects and inspection

UNIT II	**THEORY OF METAL CUTTING AND MACHINING PROCESSES**	**12**

Introduction, mechanics of metal cutting-chip formation, Merchant's circle theory cutting force calculations, tool materials. Influence of tool angles, tool life, cutting fluids, machining time calculations, Metal cutting economics, problem in merchant circle, tool life, machining time and economics.

Lathe – introduction, types, construction, mechanisms and attachments for various operations, nomenclature of single point cutting tool. Capstan and turret lathes various mechanisms, tool and loading arrangement. Automatic lathes - single spindle and multi spindle mechanisms, CNC lathes.

UNIT III	**SHAPER, PLANER AND MILLING PROCESS**	**8**

Shaper, planer and slotter: types, specifications, mechanisms, holding devices, difference between shaper and planer. Milling machine – types and specification, mechanisms, holding devices, milling operations. Milling tool nomenclature, indexing types-simple, compound and differential

UNIT IV	**DRILLING, BORING, BROACHING, SURFACE FINISHING PROCESS**	**8**

Drilling, Boring- Specification, Nomenclature of drilling and reaming tool and its specification. Broaching: Specification, types, mechanisms, nomenclature of broaching tool. Grinding process, Types of grinding machines, Grinding Wheels, Honing, Super finishing, Polishing, Metal spraying, Galvanizing, Electroplating.

UNIT V	**NON-TRADITIONAL MACHINING PROCESSES AND HIGH ENERGY RATE FORMING PROCESSES**	**9**

Non-traditional machining techniques, classification, Abrasive jet machining, Electrical Discharge Machining, E. D wire cutting, Electro chemical machining, Electron Beam Machining, Laser Beam Machining, Ultrasonic Machining.

Explosive forming, Electro hydraulic, Electromagnetic forming, Dynapack machine.

Text Books:

1. P.C. Sharma., A text book of Production Technology, S.Chand& Company ltd, 2007.
2.P.N.Rao. Manufacturing Technology-Foundry Forging and Welding, TMH publishing co, 2009.

References:

1. W.A.J. Chapman., Workshop Technology. Vol I, II& III, 1975, ELBS.
2. Roy A Lindberg, Process and Material Manufacture, PHI, 1995.
3. Kalpakjan, Manufacturing Engineering and Technology, Addison Wesley, 2005.
4. HajraChowdary S.K, The fundamentals of work shop technology Vol. I & II, Media Publishers, 1997.

BAN5V1	VALUE ADDED PROGRAM I	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Professional Courses				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student about personal value, responsibility in the society and about self confidence and self esteem
2. To introduce about goal setting, time management and planning
3. To boost the creativity, lateral thinking of the students
4. To familiarize the student on teamwork, interpersonal skills, leadership skills and ability to manage stressed situations
5. To help the student understand about decision making and self assessment

LIST OF ACTIVITIES

1	An activity to describe the personal value.
2	An activity to describe the responsibility of students in society.
3	An activity to enhance self-confidence and self-esteem.
4	An activity to make a goal setting.
5	An activity to make a time management chart.
6	An activity to describe the planning process.
7	An activity to enhance the creativity of students.
8	An activity to improve the lateral thinking.
9	An activity to describe the importance of team work.
10	An activity to enhance the interpersonal skills.
11	An activity to enhance the leadership skills.
12	An activity to manage the stressed situation.
13	An activity to describe the decision making.
14	An activity to weighing positives and negatives.
15	An activity to make a SWOT analysis.

References:

1. Value Added Program Booklet, Department of Aeronautical Engineering, 2015

BAN5L1	AERODYNAMICS LABORATORY	L	T	P	C
	Total Contact Hours – 45	0	0	3	2
	Prerequisite – Fundamentals of Fluid Mechanics, Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student to the various experimental processes to carry out structural analysis.
2. To familiarize to the student about the analysis of beams.
3. To enable the student to understand about the analysis of columns.
4. To help the student to understand about the effect of complex loading on aircraft structures.
5. To introduce to the student about the shear flow estimation in aircraft structures.

LIST OF EXPERIMENTS

1	Calibration of subsonic wind tunnel.
2	Pressure distribution over smooth cylinder
3	Pressure distribution over rough cylinder..
4	Pressure distribution over symmetric airfoil.
5	Pressure distribution over cambered airfoil.
6	Pressure distribution over a wing
7	Force measurement using wind tunnel balance.
8	Determination of base drag of a missile model.
9	Study of flow field over a backward facing step.
10	Power estimation of Wind Turbine
11	Aerodynamic studies of automotive models.
12	Study of Fanno flow
13	Study of profile drag of bodies by wake survey method.
14	Flow visualization at subsonic velocity (a) Using Tuft (b) Oil flow visualization.
15	Flow visualization studies in supersonic flows by schilren system.

References:

1. Aerodynamics Lab Manual, Department of Aeronautical Engineering, 2015

BAN5L2	AERO DESIGN AND MODELING LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Fundamentals of Aeronautics and Astronautics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To design and fabricate gliders, catapult and power gliders.
2. To design and fabricate single, double and pivoted double crank flapping wing mechanism.
3. To design and fabricate wing, vertical and horizontal stabilizer using balsa wood.
4. To design and fabricate fuselage and control surfaces using polystyrene and glass fibers.
5. To estimate discharge rate of Li-Po battery, propeller thrust and assembling Remote Control Aircraft.

LIST OF EXPERIMENTS

1	Design and fabrication of gliders using balsa wood.
2	Design and fabrication of catapult.
3	Design and fabrication of power gliders.
4	Design and fabrication of single crank flapping wing mechanism.
5	Design and fabrication of double crank flapping wing mechanism.
6	Design and fabrication of pivoted double crank flapping wing mechanism.
7	Design and fabrication of wing using balsa wood.
8	Design and fabrication of horizontal and vertical stabilizer using balsa wood
9	Design and fabrication of fuselage using hardened polystyrene.
10	Design and fabrication of control surfaces using glass fibers composite.
11	Design and fabrication of fuselage using glass fibers composite.
12	Design and fabrication of fuselage using hardened polystyrene.
13	Estimation the discharge rate of Li-Po battery for different thrust setting.
14	Estimating the propeller thrust for different voltage setting.
15	Assembling of Remote Control Aircraft.

References:

1. Aero Design and Modeling Lab Manual, Department of Mechanical Engineering, 2015

BAN5S1	COMPUTER AIDED ANALYSIS LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Aircraft Structures, Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with various computer softwares for engineering analysis
2. To familiarize the student with to the various options and types of analysis that can be carried out using ANSYS software
3. To train the student on basic structural analysis
4. To train the student on basic thermal analysis
5. To train the student on basic fluid flow analysis

LIST OF EXPERIMENTS

1	Study of ANSYS and its tools
2	Stress analysis of beams with different loading conditions
3	Stress analysis of a plate with circular hole
4	Stress analysis of an axisymmetric component
5	Vibration analysis of cantilever beam
6	Simple conduction example
7	Thermal mixed boundary example
8	Flow field analysis of jets
9	Flow field simulation over an airfoil
10	Fluid – Structure interaction

References:

1. CAA Lab Manual, Department of Aeronautical Engineering, 2015

BAN5C1	COMPREHENSION I	L	T	P	C
	Total Contact Hours : Test will be conducted at the end of the semester	0	0	0	1
	Prerequisite – All the courses up to fifth semester				
	Course Designed by – Dept. Aeronautical Engineering				

OBJECTIVES

- To provide a complete review of Aerospace Engineering topics covered up to fifth semesters, so that a comprehensive understanding is achieved.
- It will also help students to face job interviews, competitive examinations and also to enhance the

employment potential.

- To provide overview of all topics covered and to assess the overall knowledge level up to fifth semester.

BSS601	**VALUE EDUCATION AND PROFESSIONAL ETHICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Professional Courses				
	Course Designed by – Department of Humanities and Social Sciences				

OBJECTIVES

1. To teach the philosophy of Life, personal value, social value, mind cultural value and personal health
2. To teach professional ethical values, codes of ethics, responsibilities, safety, rights and related global issues.

COURSE CONTENT

UNIT I	**PHILOSOPHY OF LIFE AND INDIVIDUAL QUALITIES**	**9**

Human Life on Earth - Purpose of Life, Meaning and Philosophy of Life. The Law of Nature – Protecting Nature /Universe. Basic Culture - Thought Analysis - Regulating desire - Guarding against anger - To get rid of Anxiety – The Rewards of Blessing - Benevolence of Friendship - Love and Charity - Self – tranquility/Peace

UNIT II	**SOCIAL VALUES (INDIVIDUAL AND SOCIAL WELFARE)**	**9**

Family - Peace in Family, Society, The Law of Life Brotherhood - The Pride of Womanhood – Five responsibilities/duties of Man : - a) to himself, b) to his family, c) to his environment, d) to his society, e) to the Universe in his lives, Thriftness (Thrift)/Economics. Health - Education - Governance - People's Responsibility / duties of the community, World peace.

UNIT III	**MIND CULTURE & TENDING PERSONAL HEALTH**	**9**

Mind Culture - Life and Mind - Bio - magnetism, Universal Magnetism (God –Realization and Self Realization) - Genetic Centre – Thought Action – Short term Memory – Expansiveness – Thought – Waves, Channelising the Mind, Stages - Meditation, Spiritual Value. Structure of the body - the three forces of the body- life body relation, natural causes and unnatural causes for diseases, Methods in Curing diseases

UNIT IV	**ENGINEERING AS SOCIAL EXPERIMENTATION AND ENGINEERS'S RESPONSIBILITIES FOR SAFETY**	**9**

Engineering as Experimentation – Engineer as Responsible Experimenters – Codes of Ethics – The Challenger, case study. Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – The Three Mile Island and Chernobyl case studies.

UNIT V	**ENGINEER'S RESPONSIBILITIES FOR RIGHTS AND GLOBAL ISSUES**	**9**

Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Whistle Blowing – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Eye Witnesses and Advisors – Moral Leadership

Text Books:

1. Value Education for Health, Happiness and Harmony, The World Community Service, Centre Vethathiri Publications (Unit 1 – III).
2. Mike W Martin and Roland Schinzinger, Ethics In Engineering, Tata McGraw Hill, Newyork 2005 (Units IV & V)

References:

1. Philosophy of Universal Magnetism (Bio - magnetism, Universal Magnetism) The World Community Service Centre Vethathiri Publications (for Unit III)
2. Thirukkural with English Translation of Rev. Dr. G.U. Pope, Uma Publication, 156, Serfoji Nagar, Medical College Road,Thanjavur 613 004 (for Units I - III)
3. R S Nagaarazan, Textbook On Professional Ethics And Human Values, New Age International Publishers, 2006 (for Units IV-V)
4. Charles D Fledderman, Engineering Ethics, Prentice Hall, New Mexico, 2004(for Units IV-V)

BAN601	**AEROSPACE STRUCTURAL MATERIALS AND COMPOSITES**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with various types of aerospace composite materials.
2. To develop the understanding of composite mechanics.
3. To learn different theory of laminate design.
4. To learn different theory of failure analysis.
5. To have a clear understanding of composite fabrication process.

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9**

Atomic structure and bonding in materials-Crystal structure of materials-crystal systems- unit cells and space lattices- determination of structures of simple crystals by x-ray diffraction- miller indices of planes and directions- packing geometry in metallic- ionic and covalent solids-Concept of amorphous-single and polycrystalline structures and their effect on properties of materials-Crystal growth techniques-Imperfections in crystalline solids and their role in influencing various properties.

UNIT II	**AEROSPACE MATERIALS**	**9**

Introduction – Physical Metallurgy – Wrought Aluminum Alloys – Cast Aluminum Alloy - Production of Semi Abrogated Forms– Plastics and Rubber – Introduction to FRP, Glass and Carbon Composites– Fibers and Resins – Characteristics and Application– Super Alloys. Emerging Trends in Aerospace Materials.

UNIT III	**MECHANICS OF COMPOSITES**	**9**

Micro mechanics – Mechanics of materials approach, elasticity approach to determine material properties – Fiber Volume ratio – Mass fraction – Density of composites-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 material properties - Experimental characterization of lamina.

UNIT IV	**LAMINATION THEORY AND FAILURE ANALYSIS**	**9**

Governing differential equation for a unidirectional lamina and general laminate, angle ply and cross ply laminate, Failure criteria for composites--Failure modes of sandwich panels - Bending stress and shear flow in composite beams.

UNIT V	FABRICATION METHODS	9

Various open and closed mould processes, Manufacture of fibers, Types of resins, properties and applications, Netting analysis-Basic design concepts of sandwich construction - Materials used for sandwich construction.

Text Books:

1. Jones, R.M., "Mechanics of Composite Materials", Taylor & Francis, II Edition, 2000.
2. MadhujiMukhapadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004

References:

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of FibreComposites",John Wiley and sons. Inc., New York, 1995.
2. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.
3. Autar K Kaw, "Mechanics of Composite Materials", CRC Press, 1997.
4. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Co., New York 1998.
5. Allen Baker, "Composite Materials for Aircraft Structures", AIAA Series, Second Edition, 1999.

BAN602	FINITE ELEMENT METHODS	L	T	P	C
	Total Contact Hours – 60	4	0	0	4
	Prerequisite – Fundamentals of Fluid Mechanics, Structural Mechanics, Aerothermodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with basic numerical methods for analyzing structural components.
2. To develop the understanding of finite element modeling and analysis of one dimensional system.
3. To develop the understanding of finite element modeling and analysis of two dimensional system.
4. To develop the understanding of finite element modeling and analysis of three dimensional system
5. To acquaint with the application of finite element method to aerospace structures.

COURSE CONTENT

UNIT I	INTRODUCTION	12

Introduction to FEA - historical background - Review of various approximate methods – Raleigh Ritz's, Galerkin and finite difference methods- Governing equation and convergence criteria of finite element method - Examples of Finite Element Modeling

UNIT II	ONE DIMENSIONAL SYSTEMS	12

Direct stiffness method – spring element- Derivation of the stiffness matrix- Example of a springassemblage-Assembly of global stiffness matrix-Types of boundary conditions- The Potential energy approach –Examples-Prismatic bar under axial loading- bending of beams - Fundamentals of Finite Element Modeling – Element Division - Numbering Scheme- Coordinate and Shape Functions- The Potential Energy Approach- Assembly of Global Stiffness Matrix and Load Vector- Treatment of

Boundary Conditions- Temperature Effects- Shear Force and Bending Moment - Examples.

UNIT III	TWO DIMENSIONAL SYSTEMS	12

Plane truss structure-Introduction- Plane Trusses-Coordinate Transformation – Local & Global Coordinate- The Element Stiffness Matrix- Stress Calculations- Temperature Effects –Examples.
Plane stress & strain – Constant Strain Triangle (CST)- Isoparametric Representation- Potential Energy Approach - Element Stiffness; Force Terms Stress Calculations- Temperature Effects- Examples

UNIT IV	THREE DIMENSIONAL SYSTEMS	12

Axisymmetric formulation – Element stiffness matrix and force vector – Galerkin approach – Body forces and temperature effects – Stress calculations – Boundary conditions and Nodal Solution; Mapping and Numerical Integration– Four node quadrilateral for axisymmetric problems –Applications to cylinders under internal or external pressures – Rotating discs

UNIT V	APPLICATIONS OF FEM TO AEROSPACE STRUCTURES	12

Linear static analysis-non linear static analysis –dynamic analysis-simple harmonic motion-damping consideration-forced vibration- typical issues in contact analysis-contact impact algorithm-Case studies problems using software packages and MATLAB coding.

Text Books:

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu,"Introduction to Finite Elements in Engineering", Printice Hall India,Fourth Edition, 2011.
2. Rao. S.S., "Finite Element Methods in Engineering", Butterworth and Heinemann, Fourth Edition, 2005.

References:

1. Reddy J.N.,"An Introduction to Finite Element Method ",McGraw Hill , 3rd edition, 2005.
2. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2nd 2001.
3. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
4. Robert D Cook, David S Malkus, Michael E Plesha, "Concepts and Applications of Finite Element Analysis", John Wiley and Sons, Inc., Fourth edition, 2001.
5. Larry J Segerlind, "Applied Finite Element Analysis", John Wiley and Sons, Inc.Second Edition, 1984
6. Daryl L. Logan, "A First Course in the Finite Element Method", 5th Edition, PWS Publishing Company, Boston, 2010.

BAN603	CONTROL SYSTEM	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Basic Electrical and Electronics& Mathematics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To provide students an understanding on various physical systems, development of flight control system and their important. Also Introduce students the concept of electrical analogies to mechanical system
2. Introduce students the concept of feedback control system, Block diagram reduction technique and signal flow graph
3. To impart knowledge on various signals, system response on respective signals and time response of first order and second order system. Also to provide knowledge on steady state errors

4. To provide knowledge on concept of stability, Routh Hurwitz criteria for stability. Make student to develop Stability analysis using Bode plot, Root locus technique
5. To provide students brief knowledge on digital control system, Digital controllers. To introduce z-plane and z- transform techniques.

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9**

Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system, Analogies, mechanical and electrical components, Development of flight control systems.

UNIT II	**OPEN AND CLOSED LOOP SYSTEMS**	**9**

Feedback control systems Block diagram representation of control systems, Reduction of block diagrams, Output to input ratios.

UNIT III	**CHARACTERISTIC EQUATION AND FUNCTIONS**	**9**

Laplace transformation, Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

UNIT IV	**CONCEPT OF STABILITY**	**9**

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.

UNIT V	**SAMPLED DATA SYSTEMS**	**9**

Sampled data control systems - functional elements-sampling process - z-transforms- properties - inverse z transforms- response between samples-modified z-transforms - ZOH and First order Hold process-mapping between s and z planes - pulse transfer functions - step response - stability analysis-Jury's stability test - Introduction to digital control system, Digital Controllers and Digital PID controllers.

Text Books:

1. Ogato, Modern Control Engineering, Fifth Edition, Prentice-Hall of India Pvt.Ltd., New Delhi, 2010.
2. Azzo, J.J.D. and C.H. Houpis, Feedback control system analysis and synthesis, McGraw-Hill international 3rs Edition, 1998.

References:

1. Kuo, B.C. Automatic control systems, Prentice-Hall of India Pvt.Ltd., New Delhi, 2009.
2. Houpis, C.H. and Lamont, G.B. Digital control Systems, McGraw Hill Book co., New York, U.S.A. 1995.
3. Naresh K Sinha, Control Systems, New Age International Publishers, New Delhi, 1998.

BAN6V1	**VALUE ADDED PROGRAM II**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Professional Courses				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To boost up the technical writing skills of the student

2. To enhance the presentation skills of the student
3. To familiarize the student on attractive resume writing
4. To familiarize the student on Interviews and Group Discussions
5. To advance the problem solving ability of the student

COURSE CONTENT	
1	A business letter to a company asking for Quotation.
2	A cover letter for applying a Job.
3	A sample Email communication for the given situation.
4	A model Technical report writing.
5	An activity to analysis the audience.
6	An activity to practice the body language.
7	An activity to practice the voice modulation.
8	An activity to present a self introduction.
9	An activity to present a technical seminar.
10	An activity to write a proper resume.
11	A mock interview and group discussion.
12	Problems on critical reasoning and sentence correction.
13	Problems on number, Simple interest and compound interest.
14	Problems on Analytical and Logical Reasoning.
15	Problems on probability, permutation and combination.

References:

1. Value Added Program II Preparatory Material, Department of Aeronautical Engineering, 2015

	AIRCRAFT SYSTEM LABORATORY	L	T	P	C
BAN6L1	Total Contact Hours – 45	0	0	3	2
	Prerequisite – Aircraft Systems and Instrumentation				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. Appreciate the need of various aircraft systems, components, accessories and its functions.
2. Understand the importance of aircraft system maintenance and checks.
3. Understand the jacking procedure, leveling and symmetric checks done in the aircraft.

4. Understand the rigging procedure of the aircraft, Understand the operation of Brake torque load test and fuel clogging test
5. Develop the skills of trouble shooting and rectification of snags.

LIST OF EXPERIMENTS	
1	Aircraft systems observations during Ground run.
2	Aircraft "Mooring" procedure.
3	Aircraft "Leveling" procedure
4	Control System "Rigging check" procedure
5	Aircraft "Symmetry Check" procedure
6	Procedure to find the centre of gravity of Aircraft
7	"Flow test" to assess of filter element clogging
8	"Pressure Test" To assess hydraulic External/Internal Leakage
9	"Functional Test" to adjust operating pressure
10	"Pressure Test" procedure on aircraft fuel system components
11	"Brake Torque Load Test" on wheel brake units
12	Maintenance and rectification of snags in hydraulic systems.
13	Rectification of snags in aircraft fuel systems.
14	Tyre pressure checking and Oleo leg pressure procedure.
15	Landing gear strut wheel dismantling and assembly procedure.

References:

1. Aircraft Systems Lab Manual, Department of Aeronautical Engineering, 2015

BAN6L2	PROPULSION LABORATORY	L	T	P	C
	Total Contact Hours – 45	0	0	3	2
	Prerequisite – Aerodynamics I & II, Aircraft Propulsion				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. Understand the need of various incompressible circular and non circular jets.
2. Understand the importance of velocity in supersonic circular and noncircular jets.
3. Understand the determination of wall jet velocity profile in the aircraft.
4. Understand the need of operation of a ramjet engine.
5. Develop the studies of liquid fuel atomizer and pre-mixed flame.

LIST OF EXPERIMENTS	
1	Estimation of spread rate in incompressible circular jets.
2	Estimation of spread rate in incompressible non- circular jets.
3	Estimation of centre line velocity decay in supersonic circular jets.
4	Estimation of centre line velocity decay in supersonic non-circular jets.
5	Determination of Wall jet velocity profile.
6	Determination of Impingement jet velocity profile.
7	Study of free convective heat transfer over a flat plate.
8	Study of forced convective heat transfer over a flat plate.
9	Study of conduction heat transfer in a flat plate.
10	Operation of a subsonic Ramjet engine.
11	Flame stabilization studies using conical flame holders.
12	Velocity and pressure measurements of Co-axial jets.
13	Effect of swirl on diffusion flame.
14	Studies liquid fuel atomizers.
15	Studies on pre-mixed flame.

References:

1. Propulsion Lab Manual, Department of Aeronautical Engineering, 2015

BAN6L3	**AIRCRAFT DESIGN PROJECT I**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	0	0	4	2
	Prerequisite – Fundamentals of Aeronautics and Astronautics, Flight Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To familiarize the student to the different configurations of airplanes and on the comparison of the parameters of different airplanes to arrive at a proper selection of main parameters to design a new aircraft
2. To enable the student to be able to estimate the weight of the aircraft according to the main parameters selected
3. To enable the student to select an appropriate power plant and estimate the wing geometry according to the results of weight estimation
4. To enable the student to calculate tail dimensions and to estimate the total drag of the airplane and also to perform a stability analysis of the airplane
5. To make the student able to draft a three view diagram of the designed airplane.

METHODOLOGY	
1	Comparative configuration study of different types of airplanes
2	Comparative study on specification and performance details of aircraft
3	Preparation of comparative data sheets
4	Work sheet layout procedures
5	Comparative graphs preparation.
6	selection of main parameters for the design
7	Preliminary weight estimations.
8	Selection of main parameters,
9	Power plant selection.
10	Aerofoil selection,
11	Wing and stabilizers selection.
12	Control surfaces designing.
13	Drag estimation
14	Detailed performance calculations and stability estimates
15	Preparation of layouts of balance diagram and three view drawings

References:

1. Aircraft Performance and Design, "John D Anderson", Tata McGraw Hill Publications
2. Analysis and Design of Flight Vehicle Structures, E F Bruhn
3. CADD and CAA Lab Manuals, Department of Aeronautical Engineering, 2015

BAN701	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Fluid Dynamics, Aerodynamics I & II				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To make the student be familiar with the various fluid flow analysis technique.
2. To give insight of various computational technique for fluid flow analysis.
3. To acquaint the student with various challenges involved in computational techniques.
4. To get exposure regarding its applications and recent developments.
5. To learn advanced computing techniques like parallel computing, vector computing etc.

COURSE CONTENT		
UNIT I	**INTRODUCTION**	**10**
Basic Equations of fluid dynamics and their classification – Boundary Conditions – Incompressible inviscid flows – source, vortex and doublet panel method – Discretization of Partial Differential Equation – Truncation error, stability consistency, accuracy and convergence of numerical schemes.		
UNIT II	**GOVERNING EQUATIONS**	**9**
Conservation Equations- Direct numerical Simulation – Large Eddy Simulation – Time-Averaged Equations for Turbulent flow – Reynolds Stress Equations – Turbulence modeling		
UNIT III	**WALL EFFECTS**	**8**
The Role of Walls – Wall functions – Renormalization Group k- Models – Low-Reynolds number k-Models		
UNIT IV	**NUMERICAL METHODS**	**10**
Finite Volume Method – SIMPLE Algorithm – Advanced Discretization Methods and Numerical Schemes – Solution Procedure – Differencing Scheme, Numerical Diffusion, Relaxation Factors and convergence		
UNIT V	**APPLICATIONS**	**8**
Large Scale problems in CFD – Iterative Solvers – Preconditioning Techniques – Vector and Parallel Computing – Post Processing for Visualization.		

Text Books:

1. JiyuanTu, Guan,HengYeoh, Chaoqun Liu, "Computational Fluid Dynamics A Practical Approach" Springer Verlag,2012.
2. J. D.Anderson, "Computational Fluid Dynamics", McGraw Hill International, 2012.

References:

1. H.K. Versteeg and W. Malalsekera "An Introduction to Computational Fluid Dynamics, The Finite Volume Method", Longman Scientific & Technical, 2007.
2. T. J. Chung, "Computational Fluid Dynamics", Cambridge University Press, 2002.
3. C. Hirch, "Numerical Computation of Internal and External Flows" Volume-2, John Wiley and Sons, 1994.
4. http://www.cfdonline.com

	AVIONICS	L	T	P	C
BAN702	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Basic Electricals & Electronics, Aircraft Systems & Instrumentation and Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To provide the students an understanding on need for avionics in civil and military industry, avionics subsystems, integrated systems and design approaches

2. Introduce students about digital computer, digital numbering, digital arithmetics, logic gates, combinational logic circuits, microprocessor & memories and interface to it with analogue system
3. To introduce avionics system architecture- Data buses, MIL, ARINC standards
4. To provide idea of different cockpits, cockpit displays, panels, I/O technologies
5. To impart brief knowledge on various avionics systems. Reliability, maintainability and certification

COURSE CONTENT

UNIT I	**INTRODUCTION TO AVIONICS**	**9**

Need for avionics in civil and military aircraft and space systems – Integrated avionics and weapon systems – Typical avionics subsystems - Design approaches and recent advances - Application Technologies.

UNIT II	**PRINCIPLE OF DIGITAL SYSTEMS**	**9**

Digital computer – Digital number system- number systems and codes-Fundamentals of logic and combinational logic circuits –Digital arithmetic – interfacing with analogue systems - Microprocessors – Memories.

UNIT III	**DIGITAL AVIONICS ARCHITECTURE**	**9**

Avionics system architecture – Databuses – MIL-STD-1553B – ARINC – 420 – ARINC – 629.

UNIT IV	**FLIGHT DECKS AND COCKPITS**	**9**

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.

UNIT V	**INTRODUCTION TO AVIONICS SYSTEMS**	**9**

Communications systems- Navigation systems – Flight control systems – Radar – Electronic Warfare – Utility systems Reliability and maintainability – Certification.

Text Books:

1. Middleton, D.H., Ed., Avionics systems, Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
2. Spitzer, C.R. Digital Avionics Systems, Prentice-Hall, Englewood Cliffs, N.J., U.S.A. 1987.

References:

1. Collinson. R.P.G., Introduction to Avionics, Chapman & Hall, 1996
1. Malvino, A.P. and Leach, D.P. Digital Principles and Applications, Tata McGraw Hill, 1990.
2. Gaokar, R.S. Microprocessors Architecture-Programming and Applications,Prentice Hall, 2002..

BAN703	**HEAT TRANSFER**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Aero – Thermodynamics, Fluid Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student about the fundamentals of heat transfer.
2. To introduce to the student about the heat transfer analysis of conduction problems.
3. To introduce to the student about the heat transfer analysis of convection problems.
4. To introduce to the student about the heat transfer analysis of radiation problems.

5. To help the student understand about the various heat transfer problems in the aerospace applications.

COURSE CONTENT

UNIT I	**FUNDAMENTALS OF HEAT TRANSFER**	**9**

Modes of heat transfer: Conduction – Convection – Radiation – One dimensional steady state heat conduction: Composite Medium – Critical thickness – Effect of variation of thermal Conductivity – Extended Surfaces.

UNIT II	**CONDUCTION HEAT TRANSFER**	**9**

Unsteady state. Heat Conduction: Lumped System Analysis – Heat Transfer in Semi infinite and infinite solids – Use of Transient – Temperature charts – Application of numerical techniques.

UNIT III	**CONVECTIVE HEAT TRANSFER**	**9**

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.

UNIT IV	**RADIATIVE HEAT TRANSFER AND HEAT EXCHANGERS**	**9**

RADIATIVE HEAT TRANSFER: Concept of black body-Intensity of radiation-Laws of Black body Radiation-Radiation from non black surfaces- real surfaces – Radiation between surfaces-Radiation shape factors-Radiation shields.

HEAT EXCHANGERS: Types-overall heat transfer coefficient- LMTD- NTU method of heat exchanger Analysis.

UNIT V	**HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING**	**9**

Heat transfer problems in gas turbine, rocket thrust chambers and Re-entry vehicles –numerical problems using MATLAB.

Text Books:

1. Sachdeva, S.C. "Fundamentals of Engineering, Heat and Mass Transfer, Wiley Eastern Ltd. Fourth Edition, New Delhi, 2012.
2. Holman, J.P., "Heat Transfer ", McGraw Hill Book Co., Inc., New York, TenthEdition.,2009.

References:

1. Sutton, G.P., "Rocket Propulsion Elements ", John Wiley and Sons, 8th Edition.2010.
2. Lienhard J. H., "A Heat Transfer Text Book", Phlogiston Press, U.S.A., 2008.
3. OzisikM.N.,"Heat Transfer A Basic Approach", The McGraw-Hill Company, reprint 1995.

BAN7L1	**AIRFRAME AND AERO ENGINE REPAIR LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Aircraft Structures & Propulsion				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To know the basic concepts of the maintenance and repair of both piston and jet aero engines and the procedures followed for overhaul of aero engines.
2. To practice the procedures of dismantling of piston engine and jet engine, study of components,

accessories of both engines and handling safety precautions.

3.To demonstrate the various inspection methods such as visual inspection dimensional checks and testing methods especially NDT have studied clearly and

4. Ability to inspect surface defects, internal defects, by using dye penetrant method and identification of defects on jet engine components.

5. To know about the reassembly procedure of piston engines, jet engines and starting procedure of piston engines.

LIST OF EXPERIMENTS	
1	Dismantling and reassembling a piston engine
2	Piston Engine - cleaning, visual inspection, NDT checks.
3	Piston Engine Components - dimensional checks.
4	Study of carburetor, fuel pump, spark plug and ignition system.
5	Dismantling and reassembling a jet engine
6	Jet Engine – identification of components & defects.
7	Jet Engine – NDT checks and dimensional checks
8	Engine starting procedures.
9	Aircraft wood gluing by single scarf and double scarf joint point.
10	Welded single & double V-joints using MIG, TIG & PLASMA welding.
11	Fabric and Riveted patch repairs.
12	Tube bending and flaring
13	Sheet metal forming.
14	Repairing of Acrylic sheets.
15	Repairing the composite panels.

References:

1. Airframe and Aero Engine Repair Lab Manual, Department of Aeronautical Engineering, 2015

	AVIONICS LABORATORY	L	T	P	C
BAN7L2	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Basic Electricals and ElectronicsEngg& Avionics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To learn and practice about basic digital electronic circuits like Adder, subtractor, multiplexer, demultiplexer, encoder, decoder etc.
2. To learn about timer, shift register and comparator circuits.
3. To understand the 8-bit and 16 bit operation and to learn mnemonic's coding for 8-bit and 16-bit circuit.
4. To understand the concept of interface programming and analog to digital conversion.
5. To acquaint the concept of data buses, its configuration and remote terminal configuration.

LIST OF EXPERIMENTS	
1	Addition/Subtraction of binary numbers.
2	Multiplexer/Demultiplexer Circuits.
3	Encoder/Decoder Circuits.
4	Timer Circuits, Shift Registers, Binary Comparator Circuits.
5	Addition and Subtraction of 8-bit and 16-bit numbers.
6	Sorting of Data in Ascending & Descending order.
7	Sum of a given series with and without carry.
8	Greatest in a given series & Multi-byte addition in BCD mode.
9	Interface programming with 4 digit 7 segment Display & Switches & LED's.
10	Channel Analog to Digital Converter & Generation of Ramp, Square, Triangular waveby Digital to Analog Converter.
11	Study of Different Avionics Data Buses.
12	MIL-Std – 1553 Data Buses Configuration with Message transfer.
13	MIL-Std – 1553 Remote Terminal Configuration.

References:

1. Avionics Lab Manual, Department of Aeronautical Engineering, 2015

	AIRCRAFT DESIGN PROJECT II	L	T	P	C
BAN7L3	Total Contact Hours – 60	0	0	4	2
	Prerequisite – Flight Mechanics, Aircraft Structures I & II, Aerodynamics I & II, Aircraft Design Project I, Computer Aided Design and Analysis				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce to the student about the various kinds of loads acting on an airplane and about the detailed structural design of an aircraft

2. To enable the student to be able to estimate the loads on aircraft's wing and fuselage
3. To enable the student to able to perform a detailed design of the aircraft's wing and fuselage components
4. To enable the student to make a detailed design report and a layout of aircraft drawings
5. To enable the student to model the designed aircraft and perform a flow analysis and structural analysis

COURSE CONTENT	
1	V-n diagram for the design study
2	Gust and maneuverability envelopes
3	Critical loading performance and final V-n graph calculation
4	Structural design study – Theory approach
5	Load estimation of wings
6	Load estimation of fuselage.
7	Balancing and Maneuvering loads on tail plane, Aileron and Rudder loads.
8	Detailed structural layouts.
9	Design of some components of wings, fuselage
10	Preparation of a detailed design report with drawings.
11	Preparation of model using computer aided design packages.
12	Preparation of structural analysis report for wing.
13	Preparation of structural analysis report for Fuselage.
14	Preparation of flow analysis report for wing.
15	Preparation of flow analysis report for fuselage.

References:

1. Aircraft Performance and Design, "John D Anderson", Tata McGraw Hill Publications
2. Analysis and Design of Flight Vehicle Structures, E F Bruhn
3. CADD and CAA Lab Manuals, Department of Aeronautical Engineering, 2015

BAN7P1	TERM PAPER	L	T	P	C
	Total Contact Hours – 60	0	0	4	2
	Prerequisite – Professional Courses				
	Lab Manual Prepared by – Dept of Aeronautical Engineering				

OBJECTIVES

To teach the student the procedures and methodologies for understanding the literature survey and preparati research paper.

LIST OF TASKS

1	**PREPARING PROPOSAL** Proposed Research Topic Purposes Background Method: (suggested methods – develop your own to suit your research topic)
2	**CONDUCTING LITERATURE REVIEW** Exploring and Sharpening your Topic Evaluating Information Taking Notes and Keeping Records
3	**COMPLETING ANNOTATED BIBLIOGRAPHY** Citing Your Sources and Avoiding Plagiarism Writing and Annotated Bibliography
4	**IDENTIFYING PROBLEM STATEMENT** Meeting the Challenges of Research Developing New Information
5	**COMPLETING OUTLINE FOR THE RESEARCH** Organizing Your Project into an outline Pick up your critique paper and begin editing and incorporate the suggestions from guide
6	**SUBMITTING FIRST DRAFT** Drafting your Project Entering Conversations and Supporting Your Claims
7	**SUBMITTING WORKS CITED** Create the individual citations Apply the formatting rules
8	**SUBMITTING FULL PAPER** Revising, Editing, and Proofreading Designing and Presenting Your Project Conducting Research in the Disciplines Documenting Sources

REFERENCES:

1. Website.
2. Printed Journals

BAN8P1	PROJECT WORK	L	T	P	C

	Total Contact Hours – 18 hours per week	0	0	18	9
	Prerequisite – Basic Subjects, Aerodynamics, Aircraft Structures, Aircraft Propulsion, Flight Mechanics, Engineering Mathematics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE :

The objective of the project work is to enable the students in convenient groups of not more than 4 members on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution. Six periods per week shall be allotted in the time table and this time shall be utilized by the students to receive the directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on the progress made in the project. Each student shall finally produce a comprehensive report covering background information, literature survey, problem statement, project work details and conclusion. This final report shall be in typewritten form as specified in the guidelines.

	COMPREHENSION II	**L**	**T**	**P**	**C**
BAN8C1	Total Contact Hours : Test will be conducted at the end of the semester	0	0	0	1
	Prerequisite – All the courses upto eighth semester				
	Course Designed by – Dept. of Aeronautical Engineering				

OBJECTIVES

- To provide a complete review of Aeronautical/Aerospace Engineering topics covered up to eighth semesters, so that a comprehensive understanding is achieved.
- It will also help students to face job interviews, competitive examinations and also to enhance the employment potential.
- To provide overview of all topics covered and to assess the overall knowledge level up to eighth semester.

CORE ELECTIVE-I

	BASICS OF AIRCRAFT MAINTENANCE AND REPAIR	**L**	**T**	**P**	**C**
BANE01	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aircraft Systems				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with the fundamentals aspects of aircraft maintenance and repair.
2. To understand the maintenance and repair aspects of aircraft structures.
3. To understand the maintenance and repair aspects of primary aircraft systems.
4. To understand the maintenance and repair aspects of engine and fuel systems.
5. To understand the maintenance and repair aspects auxiliary systems and instruments.

COURSE CONTENT		
UNIT I	**FUNDAMENTAL ASPECTS OF AIRCRAFT MAINTENANCE AND REPAIR**	**9**
Importance of aircraft maintenance and repair – CAR stipulations- Hazardous materials and safety practices- Earlier aircrafts with wood structures – Maintenance of fabric covered airplanes – Aircraft painting and markings		
UNIT II	**MAINTANENACE AND REPAIR OF AIRCRAFT STRUCTURES**	**9**
Aircraft tubing repair – Special welding repairs – Soldering and brazing – Sheet metal inspection and repair – Repair practices – Rivet – Repair design – Maintenance and repair of Plastic materials – Composite materials – Inspection and repair of composite material.		
UNIT III	**MAINTENANCE OF PRIMARY AIRCRAFT SYSTEM**	**9**
Importance of various aircraft system – Hydraulic system maintenance practices – Service, flushing and inspection –Trouble shooting and maintenance of Hydraulic and Pneumatic System – Inspection and maintenance of Control system – Inspection and maintenance of landing gear.		
UNIT IV	**MAINTENANCE OF ENGINE AND FUEL SYSTEM**	**9**
Aircraft engine maintenance – Fuel system inspection – Inspection and repair of fuel tank – Trouble shooting.		
UNIT V	**MAINTENANCE OF AUXILIARY SYSTEM AND INSTRUMENTS**	**9**
Oxygen system, service and maintenance – Installation and maintenance of instruments – Testing instruments and systems – checking of a typical vacuum system.		

Text Books:

1. Kroes Watkins Delp," Aircraft Maintenance and Repair", McGraw Hill, 7th edition,New York, 2013.

References:

1. A&P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996.
2. A&P Mechanics, "General Hand Book", F A A Himalayan Book House, New Delhi, 1996.

BANE02	**ROCKETS AND MISSILES**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aerodynamics, Aircraft Stability and Control, Avionics, Aircraft Structural Materials and Composites				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

To learn about the aerodynamics and stability of Rockets and Missiles.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

	COs / POs	a	b	c	d	e	f	g	h	i	j	k	l
1	CO1												M
	CO2	H	H	H					H		H		M

	CO3	H	H	M					M		H		
	CO4	H		H					M				
	CO5	H	H	H	M				L				H
	CO6								H				H

3	Category	Humanities & Social Sciences (HS)	Basic Sciences (BS)	Engineering Sciences (ES)	Professional Core (PC)	Core Elective (CE)	Non – Major Elective (NE)	Open Elective (OE)	Project Work, Seminar, Term Paper, Internship (PR)
						X			
4	Approval	37th Meeting of Academic Council, May 2015							

COURSE CONTENT

UNIT I	ROCKET SYSTEMS	9

Ignition system in rockets – types of igniters and igniter design considerations – injection system and propellant feed systems of liquid rockets and their design considerations – design considerations of liquid rocket thrust chambers – combustion mechanisms of liquid and solid propellants.

UNIT II	AERODYNAMICS OF ROCKETS AND MISSILES	9

Airframe components of rockets and missiles – forces acting on a missile while passing through atmosphere – classification of missiles – slender body aerodynamics – method of describing forces and moments – lift force and lateral moment –lateral aerodynamic damping moment – longitudinal moment – drag estimation – body upwash and body downwash in missiles – rocket dispersion.

UNIT III	ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD	9

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 burn out velocity and altitude – estimation of culmination time and altitude.

UNIT IV	STAGING AND CONTROL OF ROCKETS AND MISSILES	9

Design philosophy behind multistaging of launch vehicles and ballistic missiles – multistage vehicle optimization – stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics – various types of thrust vector control methods including secondary injection thrust vector control – numerical problems on stage separation and multistaging.

UNIT V	MATERIALS FOR ROCKETS AND MISSILES	9

Selection criteria of materials for rockets and missiles – materials for various airframe components and engine parts – materials for thrust control devices – various adverse conditions faced by aerospace vehicles and the requirement of materials to perform under these conditions.

Text Books:

1.Martin J L Turner, Rocket and Spacecraft Propulsion, Springer-Praxis Publishing, 2001

2.Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition, 2001

Reference Books:

1. J.D.Mattingly, Elements of Propulsion - Gas Turbines and Rockets, AIAA Education series,2006,.
2. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988.
3. www.propulsion-analysis.com/
4. www.rocket.com/design-and-analysis

BANE03	EXPERIMENTAL STRESS ANALYSIS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aircraft Structures I & II				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint with the basics of measurement.
2. To understand the principle of extensometers, electrical resistance strain gauges and their application in stress analysis.
3. To understand the principle of photo elasticity and their application in stress analysis.
4. To learn brittle coating and moiré methods in stress analysis.
5. To acquaint with the non-destructive testing methods.

COURSE CONTENT

UNIT I	**MEASUREMENTS AND EXTENSOMETERS**	**9**

Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages.

UNIT II	**ELECTRICAL RESISTANCE STRAIN GAUGES**	**9**

Principle of operation and requirements, Types and their uses, Materials for strain gauge, Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

UNIT III	**PHOTOELASTICITY**	**9**

Two dimensional photo elasticity, Photo elastic materials, Concept of light – photoelastic effects, stress optic law, Transmission and Reflection polariscopes, Interpretation of fringe pattern, Compensation and separation techniques, Introduction to three dimensional photo elasticity.

UNIT IV	**BRITTLE COATING AND MOIRE METHODS**	**9**

Introduction to Moiré techniques, Brittle coating methods and Holography

UNIT V	**NON – DESTRUCTIVE TESTING**	**9**

Fundamentals of NDT, Radiography, Ultrasonics, Eddy Current testing, Fluorescent Penetrant Testing, Acoustic Emission Technique,

Text Books:

1. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw Hill Inc., New York, Fourth Edition 2005.
2. James F. Doyle ,"Modern Experimental Stress Analysis ",John Wiley & Sons, 2004.

References:

1. Hetenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, 1972.
2. Pollock A.A., "Acoustic Emission in Acoustics and Vibration Progress", Ed. Stephens R.W.B., Chapman and Hall,1993.
3. Max Mark Frocht," Photo Elasticity", John Wiley and Sons Inc., New York, 1968
4. A.J.Durelli, "Applied Stress Analysis", Prentice Hall of India Pvt Ltd., New Delhi, 1970
5. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., "Experimental Stress Analysis", Tata McGraw Hill, New Delhi, 1984.
6. Ramesh, K., " Experimental Stress Analysis", Indian Institute of Technology Madras, India,E-book,2009.

BANE04	EXPERIMENTAL AERODYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Fluid Mechanics, Aerodynamics I				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To understand the methods of low speed wind tunnel testing
2. To understand the methods of high speed wind tunnel testing
3. To acquire knowledge about measurement of pressure, velocity and temperature in flow fields
4. To understand the principles of flow visualization and analogue methods
5. To understand the principles of data acquisition and uncertainty analysis

COURSE CONTENT

UNIT I	LOW SPEED WIND TUNNEL TESTING	9

Low speed wind tunnels-Power losses in wind tunnel, energy ratio, Calibration, Flow angularity,Yaw Sphere, Yaw meter, Turbulence sphere, Pressure sphere, Wind tunnel balances, boundary correction, calculation of CL and CDforairfoils

UNIT II	HIGH SPEED WIND TUNNEL TESTING	9

High Speed wind tunnels- Blow down, Induction Type Tunnels, Losses in supersonic tunnels, Second throat, running time estimation, Hypersonic, transonic tunnels, Shock tunnels, Gun tunnels

UNIT III	MEASUREMENT TECHNIQUES	9

Pressure measurement, Hot wire anemometer, laser Doppler anemometer for turbulence and velocity measurements-Temperature measurement, Measurement of wall shear stress, Rotameters and Ultrasonic flow meters.

UNIT IV	FLOW VISUALIZATION AND ANALOGUE METHODS	9

Smoke tunnel, Tuft method, chemical coating, interferometer, Schlieren and Shadowgraph methodHeleshaw Apparatus, Hydraulic analogy, limitations of analogy		
UNIT V	**DATA ACQUISITION AND UNCERTAINTY ANALYSIS**	**9**
Measurement systems, data acquisition, signal conditioning, multiplexing, data conversion, uncertainty analysis		

Text Books:

1. Rathakrishnan. E "Instrumentation, Measurement and Experiments in Fluids", CRCPress, London, 2007

References:

1. Rae W.H and Pope. A "Low speed wind tunnel testing" John Wiley Publication, 1999
2. Pope. AandGoin. L "High speed wind tunnel testing" John Wiley, 1985

CORE ELECTIVE-II

BANE05	**HELICOPTER MAINTENANCE**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aircraft Systems and Instrumentation				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint with the basic fundamental of helicopter concept.
2. To understand the concept of inspection and maintenance of main rotor system.
3. To understand the concept of inspection and maintenance of main rotor transmission.
4. To understand the concept of inspection and maintenance of power plant and tail rotor.
5. To acquaint with airframes and related systems

COURSE CONTENT

UNIT I	**HELICOPTER FUNDAMENTALS**	**9**
Basic directions – Ground handling, bearing – Gears.		
UNIT II	**INSPECTION AND MAINTENANCE OF MAIN ROTOR SYSTEM**	**9**
Head maintenance – blade alignment – Static main rotor balance – Vibration – Tracking – Span wise dynamic balance – Blade sweeping –Electronic balancing – Dampener maintenance – Counter weight adjustment – Auto rotation adjustments – Mast & Flight Control Rotor - Mast – Stabilizer, dampeners – Swash plate flight control systems collective – Cyclic – Push pull tubes – Torque tubes – Bell cranks – Mixer box – Gradient unit control boosts – Maintenance & Inspection control rigging.		
UNIT III	**INSPECTION AND MAINTENANCE OF MAIN ROTOR TRANSMISSION**	**9**
Engine transmission coupling – Drive shaft – Maintenance clutch – Free wheeling units – Spray clutch – Roller unit – Torque meter – Rotor brake – Maintenance of these components – vibrations – Mounting systems – Transmissions.		
UNIT IV	**INSPECTION AND MAINTENANCE OF POWER PLANT & TAIL ROTOR**	**9**
Fixed wing power plant modifications – Installation – Different type of power plant maintenance. Tail		

rotor system – Servicing tail rotor track – System rigging.		
UNIT V	**AIRFRAMES AND RELATED SYSTEMS**	**9**
Fuselage maintenance – Airframe Systems – Special purpose equipment.		

Text Books:

1. JEPPESEN, "Helicopter Maintenance", Jeppesons and Sons Inc., 2000.

References:

1. "Civil Aircraft Inspection Procedures", Part I and II, CAA, English Book House, New Delhi, 1998.
2. LARRY REITHMIER, "Aircraft Repair Manual", Palamar Books Marquette, 1992.

BANE06	**SPACE MECHANICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Engineering Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce to the student about the basic concepts in space mechanics and about the laws that govern motion in space
2. To enable the student to decide on the locations for satellite injections in to the orbit and the various perturbations on satellites in space
3. To acquaint the student about the interplanetary trajectories and to select/design appropriate trajectory according to mission requirements
4. To introduce to the student about the trajectories for ballistic missiles
5. To familiarize the student about the different types of materials used in spacecrafts

COURSE CONTENT

UNIT I	**BASIC CONCEPTS AND THE GENERAL N- BODY PROBLEM**	**9**
The solar system – reference frames and coordinate systems – terminology related to the celestial sphere and its associated concepts – Kepler's laws of planetary motion and proof of the laws – Newton's universal law of gravitation - the many body problem- Lagrange-Jacobi identity – the circular restricted three body problem – libration points – the general N-body problem two body problems – relations between position and time.		
UNIT II	**SATELLITE INJECTION AND SATELLITE PERTURBATIONS**	**9**
General aspects of satellite injection – satellite orbit transfer – various cases – orbit deviations due to injection errors – special and general perturbations – Cowell's method and Encke's method – method of variations of orbital elements – general perturbations approach.		
UNIT III	**INTERPLANETARY TRAJECTORIES**	**9**
Two-dimensional interplanetary trajectories – fast interplanetary trajectories – three dimensional interplanetary trajectories – launch of interplanetary spacecraft – trajectory estimation about the target planet – concept of sphere of influence – Lambert's theorem		
UNIT IV	**BALLISTIC MISSILE TRAJECTORIES**	**9**
Introduction to ballistic missile trajectories – boost phase – the ballistic phase – trajectory geometry – optimal flights – time of flight – re-entry phase – the position of impact point – influence coefficients.		
UNIT V	**MATERIALS FOR SPACECRAFT**	**9**
Space environment – peculiarities of space environment – effect of space environment on materials of		

spacecraft structure – materials required for the construction of space craft – TPS for re-entry space vehicles.
Text Books: 1.Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman &Co., Ltd, London, 1982 2. Parker, E.R., "Materials for Missiles and Spacecraft", McGraw Hill Book Co. Inc., 1982.
References: 1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition, 2001.

BANE07	**THEORY OF VIBRATIONS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Engineering Mechanics, Flight Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To know about the role of Vibrations, vibration analysis and ideas about Aero elasticity in engineering and industry.
2. To make thorough understanding of single degree of freedom, Two degrees of freedom and multi degrees of freedom systems and deriving equations to solve for natural frequency.
3. To understand the Newton second Law, Energy method and know how to use it to solve single degree of freedom systems.
4. To understand the approximate methods to solve vibration engineering problems in Two degree and multi degree of freedom systems.
5. To understand the collars triangle and various aero elastic phenomena in the aircraft structural components.

COURSE CONTENT

UNIT I	**SINGLE DEGREE OF FREEDOM SYSTEMS**	**9**
Introduction to simple harmonic motion, D'Alembert's Principle, Free vibrations – Damped vibrations – Forced Vibrations, with and without damping – support excitation – Vibration measuring instruments.		
UNIT II	**MULTI DEGREES OF FREEDOM SYSTEMS**	**9**
Two degrees of freedom systems - Static and Dynamic couplings - vibration absorber- Principal co-ordinates - Principal modes and orthogonal condition - Eigen value problems - Hamilton's principle - Lagrangean equations and application.		
UNIT III	**CONTINUOUS SYSTEMS AND APPROXIMATE METHODS**	**9**
Vibration of elastic bodies - Vibration of strings - Longitudinal - Lateral and Torsional vibrations.Approximate methods - Rayleigh's method - Dunkerly's method – Rayleigh-Ritz method, Matrix Iteration method.		
UNIT IV	**ELEMENTS OF AEROELASTICITY**	**9**
Concepts – Coupling – Aero elastic instabilities and their prevention – Basic ideas on wing divergence, loss and reversal of aileron control – aileron efficiency-semi rigid theory and successive approximations-Lift distribution – rigid and elastic wings. Tail efficiency. Effect of elastic deformation on static longitudinal stability.		
UNIT V	**FLUTTER PHENOMENON**	**9**

Physical interpretation of the classical Flutter – Non-dimensional parameters – stiffness criteria – Dynamic mass balancing – Dimensional similarity - Flutter analysis- Calculation of the flutter speed via P-Method – concept of dummy structural damping , violent flutter, moderate flutter and mild flutter and prevention of flutter.

Text Books:

1. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 2008.
2. Thomson W T, 'Theory of Vibration with Application' - CBS Publishers, 1990.

References:

1. Timoshenko S., Vibration Problems in Engineering – John Wiley and Sons, New York, 1993.
2. Bisplinghoff R.L., Ashely H and Hogman R.L., Aeroelasticity – Addision Wesley Publication, New Tork, 1983.
3. R.H. Scanlan and R.Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.
4. R.D.Blevins, "Flow Induced Vibrations", Krieger Pub Co., 2001

BANE08	HELICOPTER AERODYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Aeronautics and Astronautics, Aerodynamics I				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint with the basics of rotating wing concept.
2. To understand the concept of hovering flight dynamics.
3. To understand the concept of forward flight dynamics.
4. To analyze the climb and descent performance.
5. To acquaint with ground effect machines.

COURSE CONTENT

UNIT I	INTRODUCTION TO ROTATING WING CONCEPT	9

Evolution of helicopter-Helicopter configurations - Configurations based on Torque reaction – Jet rotors and compound helicopters –Methods of Control, rotor blade pitch control, –Collective pitch and Cyclic pitch – Lead – Lag and flapping hinges.

UNIT II	HOVERING FLIGHT DYNAMICS	9

Actuator disc theory-Blade Element Theory-ideal twist Induced & profile power-Figure of merit-Thrust and power coefficients-calculation of drag, torque, power-Ground effect in hover- Estimation of hover ceiling.

UNIT III	FORWARD FLIGHT DYNAMICS	9

Forward flight performance-Parasite drag and Power-Stall limitations-flapping-cyclic Pitch - Autorotation in hover and in forward flight-Dead man's curve.

UNIT IV	CLIMB AND DESCENT PERFORMANCE	9

Vertical flight-flow patterns surrounding the rotor-Power required in climb and descent- Descent speed calculations-Take-off techniques.

UNIT V	GROUND EFFECT MACHINES	9
Types – Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machines – Drag of hovercraft on land and water –Applications of hovercraft.		
Text Books: 1. Gupta. L "Helicopter Engineering", Himalayan Books, 1996 2. Seddon. J "Basic Helicopter Aerodynamics" AIAA education series, 1990.		
References: 1. Gessow A & Myers G.C "Aerodynamics of Helicopter" Mac Millan& Co, 1987 2. Saunders "Dynamics of Helicopter flight", John Wiley, 1975 3. Newman. S "Foundation of Helicopter Flight" Halsted Press, 1994		

CORE ELECTIVE-III

BANE09	AIRCRAFT ENGINE REPAIR AND MAINTENANCE	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aircraft Systems				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1.To know about the hydraulic, pneumatic, brake and landing gear systems principle, function of components, types and operation of typical system.
2. To study and differentiate conventional and modern aircraft control systems and engine control systems
3. To study about layout, components, functions of fuel, lubrication, starting, ignition systems of piston and jet engines.
4. To understand air-conditioning, air cycle, vapor cycle, oxygen, deicing, anti icing and fire protection systems of aero plane.
5. To study construction and operation of flight, navigation instruments and engine instruments installed in the aero plane.

COURSE CONTENT

UNIT I	INSPECTIONS AND TROUBLE SHOOTING OF PISTON ENGINES	9
Need for Inspection, maintenance and trouble shooting in Piston engine – Inspection of all 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 – Details of carburetion and injection systems for small and large engines – Ignition system components – Spark plug – Maintenance and inspection check to be carried out.		
UNIT II	**INSPECTION AND TROUBLE SHOOTING OF PROPELLER**	**9**
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.		
UNIT III	**OVERHAULING OF PISTON ENGINES**	**9**
Symptoms of failure - Fault diagnostics - Case studies of different piston engine systems - Rectification during testing equipments for overhaul: Tools and equipments requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection - Methods		

and instruments for non destructive testing techniques - Equipment for replacement of parts and their repair. Engine testing: Engine testing procedures and schedule preparation - Online maintenance

UNIT IV	INSPECTION AND TROUBLE SHOOTING OF GAS TURBINE ENGINE	9

Gas turbine engine inspection & checks – Use of instruments for online maintenance – Maintenance procedures of gas turbine engines – Trouble shooting and rectification procedures – Component maintenance procedures – Systems maintenance procedures. Special inspection procedures: Foreign Object Damage – Blade damage – etc. Gas turbine testing procedures – test schedule preparation – Storage of Engines – Preservation and de-preservation procedures.

UNIT V	OVERHAULING OF GAS TURBINE ENGINES	9

Gas turbine Engine Overhaul procedures – Inspections and cleaning of components – Repairs schedules for overhaul – Balancing of Gas turbine components. Trouble Shooting - Procedures for rectification – Condition monitoring of the engine on ground and at altitude – engine health monitoring and corrective methods.

Text Books:

1. KROES & WILD, "Aircraft Power plants", 7th Edition – McGraw Hill, New York, 1994.

References:

1. TURBOMECA, "Gas Turbine Engines", The English Book Store, New Delhi, 1995.
2. UNITED TECHNOLOGIES PRATT & WHITNEY, "The Aircraft Gas turbine Engine and its Operation", The English Book Store, New Delhi.

BANE10	CRYOGENIC ROCKET PROPULSION	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Engineering Thermodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce to the student the basics of cryogenic systems and associated processes.
2. To acquaint the student with the propellants used in cryogenic technology.
3. To introduce the various equipments and accessories used in cryogenic rocket propulsion.
4. To familiarize the student to the different flow circuits and parts in a cryogenic engine.
5. To enable the student to understand about various challenges in implementing cryogenic rocket technology.

COURSE CONTENT

UNIT I	INTRODUCTION TO CRYOGENIC SYSTEMS	9

Review of Basic Thermodynamics, Properties of Cryogenic fluids, First and Second Law approaches to the study of thermodynamic cycles, Isothermal, Adiabatic and Isenthalpic processes. Liquefaction systems, ideal, Cascade, LindeHampson and Claude cycles and their derivatives; Refrigerators: Stirling, Gifford-McMahon cycles and their derivatives. Cryogenic Insulations: Foam, Fibre, powder and Multilayer. Applications – common materials used.

UNIT II	CRYO FUEL SYSTEMS	9

Cryogenic and semi – cryogenic propellants - Hydrogen - properties, production and pretreatment - Liquefaction of hydrogen - Linde, Claude and helium - hydrogen condensing cycles, Ortho-para conversion. Storage and handling of liquefied hydrogen - applications of hydrogen, and its safety.

UNIT III	CRYO EQUIPMENTS AND ACCESSORIES	9

Mechanical and Thermal Properties of engineering materials at low temperatures; Compressors: types, construction and characteristics; Expansion machines: characteristics of reciprocating and turbine expanders, design of J-T expander; Heat exchangers: theory, types, design approaches and selection criteria, Irreversibilities in cryogenic Heat exchangers; Design of cryogenic storage vessels, transfer devices, insulation system, valves; Characteristics of cryogenic pumps, Instrumentation in cryogenic systems; Safety in cryogenic systems.

UNIT IV	CRYOGENIC ENGINES	9

Fluid circuits of various cryogenic engines and semi-cryogenic engines; Design of regeneratively cooled combustion chamber, film cooling, dump cooling, transpiration cooling and radiation cooling. Design of expansion nozzle- characteristics, Design of injector– hydraulic characteristics; Engine thrust and mixture ratio control, Igniters, Propellant tanks.

UNIT V	CHALLENGES IN CRYOGENIC ROCKET TECHNOLOGY	9

Problems in storage and handling of cryogenic propellants: safety aspects, Thermal protection systems for stage tanks, Thermal stratification- destratification, Geysering effect – geysering elimination, Zero "g" problems – restart mechanism.

Text Books:

1. "Operation of a Cryogenic Rocket Engine", "Kitsche, Wolfgang", Springer Publications, 2011.
2. "A text book of Cryogenics", "Valery V. Kostionk", Discovery Publishing House, 2010.

References:

1. "Rocket Propulsion Elements", "Sutton G. P., Bibliarz"

BANE11	THEORY OF PLATES AND SHELLS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint with the classical plate theory.
2. To analyze the plates of various shapes.
3. To learn the concept of Eigen value analysis.
4. To learn various numerical approximation method for plate analysis.
5. To acquaint the concept of shell structures.

COURSE CONTENT

UNIT I	CLASSICAL PLATE THEORY	9

Classical Plate Theory – Assumptions – Differential Equations – Boundary Conditions – Axi-Symmetric Loading.

UNIT II	PLATES OF VARIOUS SHAPES	9

Navier's Method of Solution for Simply Supported Rectangular Plates – Levy's Method of Solution for Rectangular Plates under Different Boundary Conditions – Annular Plates – Plates of other shapes.		
UNIT III	**EIGEN VALUE ANALYSIS**	**9**
Stability and Free Vibration Analysis of Rectangular Plates.		
UNIT IV	**APPROXIMATE METHODS**	**9**
Rayleigh – Ritz, Galerkin Methods– Finite Difference Method – Application to Rectangular Plates for Static, Free Vibration and Stability Analysis.		
UNIT V	**SHELLS**	**9**
Basic Concepts of Shell Type of Structures – Membrane and Bending Theories for Circular Cylindrical Shells.		

Text Books:

1. Timoshenko, S.P. Winowsky. S., and Kreger, Theory of Plates and Shells, McGraw Hill Book Co., 1990.
2. Varadhan. T. K. &Bhaskar.K., "Analysis of Plates – Theory and Problems", Narosa Publishing House, 2000

References:

1. Flugge, W. Stresses in Shells, Springer – Verlag, 1985.
2. Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, McGraw Hill Book Co.1986.
3. Harry Kraus, 'Thin Elastic Shells', John Wiley and Sons, 1987.
4. Llyod Hamilton, Donald, "Beams, Plates and Shells", McGraw Hill, 1976.
5. AnselUgural, Stresses in Plates & Shells, McGraw Hill, 1981
6. Reddy.J.N., "Theory & Analysis of Elastic Plates", CRC, I Edition, 1999

BANE12	**HYPERSONIC AERODYNAMICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aerodynamics I & II				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To study the environment around hypersonic vehicles created by strong shock waves.
2. To introduce students to real gas effects caused by high temperature conditions.
3. To study pressure and heat transfer phenomena at the stagnation point of a hypersonic vehicle.
4. To study the distribution of pressure around a general vehicle shape.
5. To study the distribution of heat transfer and skin friction around a general vehicle shape.

COURSE CONTENT

UNIT I	**FUNDAMENTALS OF HYPERSONIC AERODYNAMICS**	**9**
Introduction to hypersonic aerodynamics-differences between hypersonic aerodynamics and supersonic aerodynamics-concept of thin shock layers-hypersonic flight paths – hypersonic similarity parameters-shock wave and expansion wave relations of inviscid hypersonic flows.		
UNIT II	**SIMPLE SOLUTION METHODS FOR HYPERSONIC IN VISCID FLOWS**	**9**
Local surface inclination methods-Newtonian theory-modified Newtonian law-tangent wedge and tangent cone and shock expansion methods-approximate theory-thin shock layer theory.		

UNIT III	VISCOUS HYPERSONIC FLOW THEORY	9
Boundary layer equation for hypersonic flow-hypersonic boundary layers-self similar and non self similar boundary layers-solution methods for non self similar boundary layers aerodynamic heating.		
UNIT IV	**VISCOUS INTERACTIONS IN HYPERSONIC FLOWS**	**9**
Introduction to the concept of viscous interaction in hypersonic flows-strong and weak viscous interactions-hypersonic viscous interaction similarity parameter-introduction to shock wave boundary layer interactions.		
UNIT V	**INTRODUCTION TO HIGH TEMPERATURE EFFECTS**	**9**
Nature of high temperature flows-chemical effects in air-real and perfect gases-Gibb's free energy and entropy-chemically reacting mixtures-recombination and dissociation.		

Text Books:

1. John. D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", AIAA Series, New York, 2006.

References:

1. John. D. Anderson. Jr ., "Modern compressible flow with historical perspective", McGraw Hill Publishing Company, New York, 1996.
2. John. T Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc.,Washington. D.C., 1994.

NON MAJOR ELECTIVE-I

BANE13	AN INTRODUCTION TO COMBUSTION	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Aerothermodynamics, Aircraft Propulsion				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint with the basics of combustion.
2. To understand the combustion process in aircraft piston engines.
3. To understand the combustion process in gas turbine engines.
4. To understand the combustion process in scramjet engines.
5. To understand the combustion process in rocket engines.

COURSE CONTENT

UNIT I	INTRODUCTION TO COMBUSTION	9
Thermo chemical equations – heat of reaction- first, second and third order reactions – premixed flames – diffusion flames – measurement of burning velocity – various methods – effect of various parameters on burning velocity – flame stability – deflagration – detonation – Rankine-Hugoniot curves – radiation by flames		
UNIT II	**COMBUSTION IN AIRCRAFT PISTON ENGINES**	**9**
Introduction to combustion in aircraft piston engines – various factors affecting the combustion efficiency - fuels used for combustion in aircraft piston engines and their selection – detonation in piston engine combustion and the methods to prevent the detonation		

UNIT III	COMBUSTION IN GAS TURBINE ENGINES	9
Combustion in gas turbine combustion chambers - recirculation – combustion efficiency, factors affecting combustion efficiency, fuels used for gas turbine combustion chambers – combustion stability – ramjet combustion – differences between the design of ramjet combustion chambers and gas turbine combustion chambers- flame holders types – numerical problems.		
UNIT IV	**COMBUSTION IN SCRAMJET ENGINES**	**9**
Introduction to supersonic combustion – need for supersonic combustion for hypersonic air-breathing propulsion- supersonic combustion controlled by diffusion, mixing and heat convection – analysis of reactions and mixing processes - supersonic burning with detonation shocks - various types of supersonic combustors.		
UNIT V	**COMBUSTION IN ROCKET ENGINES**	**9**
Solid propellant combustion - double and composite propellant combustion – various combustion models – combustion in liquid rocket engines – single fuel droplet combustion model – combustion hybrid rockets		

Text Books:

1.Stephen R turns, ”An Introduction to Combustion”, Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, Reprint 2013.

2. Lefebvre AG and Dilip R Ballal, “Gas Turbine Combustion”, CRC press ,Third Edition, 2010.

References:

1.Warnatz J, Maas U and Dibble RW, ”Combustion”, Springer, Fourth Edition,2006.

2. Beer, J.M., and Chiger, N.A. “Combustion Aerodynamics”, Applied Science Publishers Ltd., London, 1981.

3. Sharma, S.P., and Chandra Mohan, “Fuels and Combustion”, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 1987

BANE14	PRINCIPLES OF TURBO MACHINERY IN AIR BREATHING ENGINES	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aircraft Propulsion				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To familiarize the student on the working principle of air breathing engines
2. To enable the student to be able to design axial flow compressors and fans based on the operating requirements
3. To student should be able to design axial flow turbines based on the operating requirements
4. To acquaint the student about the designing procedure for centrifugal compressors
5. To enable the student to design radial flow turbines based on operating conditions

COURSE CONTENT

UNIT I	INTRODUCTION TO TURBOMACHINERIES	5
Introduction - Blades and flow - Work input and output - Dynamic scaling – Losses and Efficiency		
UNIT II	**AXIAL FLOW COMPRESSORS AND FANS**	**13**

Radial Equilibrium Equation; Design of compressor blades; 2-D blade section design : Airfoil Data; Axial Flow Track Design; Axial compressor characteristics; Multi-staging of compressor characteristics; Transonic Compressors; Shock Structure Models in Transonic Blades; Transonic Compressor Characteristics; 3-D Blade shapes of Rotors and Stators; Instability in Axial Compressors; Loss of Pressure Rise; Loss of Stability Margin; Noise problem in Axial Compressors and Fans

UNIT III	**AXIAL FLOW TURBINES**	**9**

Turbine Blade 2-D (cascade) analysis Work Done; Degree of Reaction; Losses and Efficiency; Flow Passage; Subsonic, transonic and supersonic turbines, Multi-staging of Turbine; Exit flow conditions; Turbine Cooling; Turbine Blade design – Turbine Profiles : Airfoil Data and Profile construction

UNIT IV	**CENTRIFUGAL COMPRESSORS:**	**9**

Elements of centrifugal compressor/ fan; Inlet Duct Impeller; Slip factor; Concept of Rothalpy; Modified work done; Incidence and lag angles; Diffuser ; Centrifugal Compressor Characteristics; Surging; Chocking; Rotating stall; Design

UNIT V	**RADIAL TURBINE:**	**9**

Thermodynamics and Aerodynamics of radial turbines; Radial Turbine Characteristics; Losses and efficiency; Design of radial turbine

Text Books:

1. Nicholas Cumpsty, Compressor Aerodynamics, 2004, Kreiger Publications, USA.
2. Johnson I.A., Bullock R.O. NASA-SP-36, Axial Flow Compressors, 2002 (re-release), NTIS.
3. Ahmed F. El-Sayed; Aircraft Propulsion and Gas Turbine Engines; CRC press, 2008

References:

1. El-Wakil, M M; Power plant Technology, 1984, McGraw-Hill Pub.
2. NASA-SP-290, Axial Flow turbines, 2002 (re-release), NTIS, USA.
3. J H Horlock, Axial flow compressors, Butterworths, 1958, UK.
4. J H Horlock, Axial Flow Turbines, Butterworths, 1965, UK.
5. B Lakshminarayana; Fluid Mechanics and Heat Transfer in turbomachineries, Â 1995, USA.

BANE15	**NANO SCIENCE TECHNOLOGY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Engineering Physics, Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint with the fundamentals of viscous flow.
2. To learn the different regime of viscous flow and its solution.
3. To understand the concept of laminar boundary layer.
4. To understand the concept of turbulent boundary layer.
5. To acquaint the concept of compressible boundary layer.

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9**

Introduction to nano scale materials - atomic & molecular size. Scientific revolutions-nanotechnology application area. Scope of nano science and technology

UNIT II	NANOSTRUCTURES AND DIMENSIONS	9
Classification of nanostructures-zero, one, two and three dimensional nanostructures. Size Dependency in Nanostructures-quantum size effects in nanostructures. Chemistry of tailored nano shapes.		
UNIT III	**NANOMATERIAL SYNTHESIS**	**9**
Synthesis of nanomaterials-top down and bottom up approach. Method of nanomaterials preparation – wet chemical synthesis-mechanical grinding-gas phase synthesis.		
UNIT IV	**NANOMATERIAL PROPERTIES**	**9**
Surface to volume ratio. Surface properties of nanoparticles. Mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. Size dependent properties-size dependent absorption spectra. Shape impact.		
UNIT V	**PHYSICAL PROPERTIES OF NANOSTRUCTURED MATERIALS**	**9**
Quantum dots-optical properties and applications. Carbon nano tubes-physical properties and applications. Magnetic behavior of nanomaterials. Electronic transport in quantum wires. Surface chemistry of tailored monolayer.		

Text Books:

1. T. Pradeep, " Nano the Essential Nanoscience and Nanotechnology", Tata McGraw hill, 2007.
2. Mick Wilson, KamaliKannargare., Geoff Smith, "Nano technology: Basic Science and Emerging Technologies", Overseas Press, 2005.

References:

1. Charles P. Poole, Frank J. Owens, "Introduction to Nanotechnology", Wiley Inter Science, 2003.
2. Mark A. Ratner, Daniel Ratner, "Nanotechnology: A gentle introduction to the next Big Idea", Prentice HallP7R:1st Edition, 2002.
3. J. Dutta, H. Hoffmann, "Nanomaterials", Topnano-21, 2003.

BANE16	UNMANNED AERIAL VEHICLE	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Aeronautics and Astronautics, Flight Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce to the student about the basic ideas of Unmanned Aerial Vehicles
2. To familiarize the students about the aerodynamics and airframe configurations
3. To accustom the student to the wide variety of unmanned aerial vehicles
4. To acquaint the student about the various communication and navigation systems of unmanned aerial vehicles
5. To enable the student to understand about the control and stability of UAV's

COURSE CONTENT

UNIT I	INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS	9
The Systemic Basis of UAS-System Composition- Conceptual Phase-Preliminary Design-Selection of the System- Some Applications of UAS		
UNIT II	**AERODYNAMICS AND AIRFRAME CONFIGURATIONS**	**9**

Lift-induced Drag - Parasitic Drag - Rotary-wing Aerodynamics - Response to Air Turbulence - Airframe Configurations Scale Effects - Packaging Density – Aerodynamics - Structures and Mechanisms - Selection of power-plants - Modular Construction - Ancillary Equipment		
UNIT III	**CHARACTERISTICS OF AIRCRAFT TYPES**	**9**
Long-endurance, Long-range Role Aircraft – Medium-range, Tactical Aircraft - Close-range/Battlefield Aircraft - MUAV Types - MAV and NAV Types - UCAV - Novel Hybrid Aircraft Configurations - Research UAV		
UNIT IV	**COMMUNICATIONS NAVIGATION**	**9**
Communication Media - Radio Communication - Mid-air Collision (MAC) Avoidance - Communications Data Rate and Bandwidth Usage - Antenna Types NAVSTAR Global Positioning System (GPS) - TACAN - LORAN C - Inertial Navigation - Radio Tracking - Way-point Navigation		
UNIT V	**CONTROL AND STABILITY**	**9**
HTOL Aircraft - Helicopters - OTE/OTE/SPH - Convertible Rotor Aircraft - Payload Control - Sensors – culmon filter- Autonomy		

Text Books:

1. Reg Austin., Unmanned Aircraft Systems, John Wiley and Sons., 2010

References:

1. Milman&Halkias, "Integrated Electronics", McGraw Hill, 1999.
2. Malvino& Leach, "Digital Principles & Applications", McGraw Hill, 1986
3. Collinson R.P.G, "Introduction to Avionics", Chapman and Hall, India, 1996
4. BernadEtikin,"Dynamic of flight stability and control", John Wiley, 1972

NON MAJOR ELECTIVE-II

BANE17	**BOUNDARY LAYER THEORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Maths				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint with the fundamentals of viscous flow.
2. To learn the different regime of viscous flow and its solution.
3. To understand the concept of laminar boundary layer.
4. To understand the concept of turbulent boundary layer.
5. To acquaint the concept of compressible boundary layer.

COURSE CONTENT

UNIT I	**FUNDAMENTAL EQUATIONS OF VICOUS FLOW**	**9**
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		
UNIT II	**SOLUTIONS OF VICOUS FLOW EQUATIONS**	**9**

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.

UNIT III	LAMINAR BOUNDARY LAYER EQUATIONS	9

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, Blasius solution for flat-plate flow, 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

UNIT IV	TURBULENT BOUNDARY LAYEREQUATIONS	9

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, Eddy Viscosity, mixing length , Turbulence modeling

UNIT V	COMPRESSIBLE BOUNDARY LAYERSEQUATIONS	9

Compressible boundary layer equations, Recovery factor, similarity solutions, laminar supersonic Cone rule, shock-boundary layer interaction

Text Books:

1. White, F. M., Viscous Fluid Flow, McGraw-Hill & Co., Inc., New York, 2005.

References:

1. Schlicting, H., Boundary Layer Theory, McGraw-Hill, New York, 2000.
2. Reynolds, A, J., Turbulent Flows Engineering, John Wiley and Sons, 1980.

BANE18	FATIGUE AND FRACTURE MECHANICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To familiarize the student about the basic terminologies of fatigue and fracture mechanics
2. To enable the student to grasp the various statistical tools used in fatigue analysis
3. To acquaint the student about the physical processes taking place during fatigue
4. To introduce to the student about the mechanism taking place during fracture
5. To make the student realize about the importance of fatigue and fracture mechanics in aerospace industry

COURSE CONTENT

UNIT I	FATIGUE OF STRUCTURES	9

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.

UNIT II	STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR	9

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.

UNIT III	PHYSICAL ASPECTS OF FATIGUE	9

Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.

UNIT IV	FRACTURE MECHANICS	9

Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Irwin extension of Griffith's theory to ductile materials - stress analysis of "cracked bodies - Effect of thickness on fracture toughness - stress intensity factors for typical 'geometries.

UNIT V	FATIGUE DESIGN AND TESTINIG	9

Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.

Text Books:

1. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009.
2..T.L. Anderson, Fracture Mechanics - Fundamentals and Applications, 3rd Edition, Taylor and Francis Group, 2005

References:

1. K. R.Y. Simha, Fracture Mechanics for Modern Engineering Design, Universities Press (India) Limited, 2001
2. D.Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, Dordrecht, 1986.
3. Barrois W, Ripely, E.L., "Fatigue of aircraft structure," Pergamon press. Oxford, 1983

BANE19	HIGH TEMPERATURE MATERIALS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with the fundamentals of creep.
2. To make the student understand about design with creep resistance.
3. To familiarize the student about fracture, cracks and their mechanics.
4. To introduce to the student about oxidation and corrosion in hot environments.
5. To acquaint the student with various super alloys and other materials.

COURSE CONTENT

UNIT I	CREEP	9

Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate.

UNIT II	DESIGN FOR CREEP RESISTANCE	9

Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.

UNIT III	FRACTURE	9
Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture, and ductile fracture due to micro void coalescence-diffusion controlled void growth; fracture maps for different alloys and oxides.		
UNIT IV	**OXIDATION AND HOT CORROSION**	**9**
Oxidation, Pilling, Bedworth ratio, kinetic laws of oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep, methods of combat hot corrosion.		
UNIT V	**SUPER ALLOYS AND OTHER MATERIALS**	**9**
Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, embrittlement, solidification of single crystals, Intermetallics, high temperature ceramics.		

Text Books:

1. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals,USA, 1985.
2. Hertzberg R. W., "Deformation and Fracture Mechanics of Engineering materials", 4th Edition, John Wiley, USA, 1996.
3. Courtney T.H, "Mechanical Behavior of Materials", McGraw-Hill, USA, 1990.

References:

1. Boyle J.T, Spencer J, "Stress Analysis for Creep", Butterworths, UK, 1983.
2. Bressers. J., "Creep and Fatigue in High Temperature Alloys", Applied Science, 1981.
3. McLean D., "Directionally Solidified Materials for High Temperature Service", TheMetals Society, USA, 1985.

NON MAJOR ELECTIVE-III

BANE20	WIND ENERGY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aerodynamics I				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To familiarize the student about the fundamentals about wind energy and the various measurements associated with it
2. To acquaint the student with the aerodynamics of wind turbines
3. To introduce to the student about the components of wind turbines and the gear coupled generators
4. To introduce to the student about the direct rotor coupled generators
5. To accustom the student to the control systems and monitoring systems for wind turbines

COURSE CONTENT

UNIT I	WIND ENERGY FUNDAMENTALS & WIND MEASUREMENTS	9
Wind Energy Basics, Wind Speeds and scales, Terrain, Roughness, Wind Mechanics, PowerContent, Class of wind turbines, Atmospheric Boundary Layers, Turbulence. Instrumentation for wind measurements, Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis		

UNIT II	AERODYNAMICS THEORY & WIND TURBINE TYPES	9
Airfoil terminology, Blade element theory, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Types of loads; Sources of loads Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator		
UNIT III	**GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION**	**9**
Electronics Sensors /Encoder /Resolvers, Wind Measurement : Anemometer & Wind Vane, Grid Synchronization System, Soft Starter, Switchgear [ACB/VCB], Transformer, Cables and assembly, Compensation Panel, Programmable Logic Control, UPS, Yaw & Pitch System : AC Drives, Safety Chain Circuits, Generator Rotor Resistor controller (Flexi Slip), Differential Protection Relay for Generator, Battery/Super Capacitor Charger & Batteries/ Super Capacitor for Pitch System, Transient Suppressor / Lightning Arrestors, Oscillation & Vibration sensing		
UNIT IV	**DIRECT ROTOR COUPLED GENERATOR**	**9**
Excited Rotor Synch. Generator / PMG Generator, Control Rectifier, Capacitor Banks, Step Up / Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit (Voltage and Current), Transformer, Safety Chain Circuits		
UNIT V	**MODERN WIND TURBINE CONTROL & MONITORING SYSTEM**	**9**
Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA & Databases: Remote Monitoring and Generation Reports, Operation &Maintenance for Product Life Cycle, Balancing technique (Rotor &Blade), FACTS control & LVRT & New trends for new Grid Codes.		

Text Books:

1.Kaldellis J.K, Standalone and Hybrid Wind Energy Systems, CRC Press, 2010
2. Mario Garcia –Sanz, Constantine H. Houpis, Wind Energy Systems,CRC Press 2012

References:

1.Freris, L.L., Wind Energy Conversion Systems, Prentice Hall, 1990
2.Spera, D.A., Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press, 1994.
3. Duffie, A and Beckmann, W. A., Solar Engineering of Thermal Processes, John Wiley, 1991.
4. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press,1996.

BANE21	SATELLITE TECHNOLOGY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Basic Electrical and Electronics, Engineering Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce to the student about different types of satellites and their functions
2. To accustom the student to the governing equations of motion and orbital mechanics
3. To acquaint the student to the structure of the satellites and the components used and their thermal protection
4. To familiarize the student about the control system for spacecraft

5. To enable the student to understand about the power system in a satellite and the various bus electronics used

COURSE CONTENT

UNIT I	**INTRODUCTION TO SATELLITE SYSTEMS**	**9**

Common satellite applications and missions – Typical spacecraft orbits – Definitions of spin the three axis stabilization-Space environment – Launch vehicles – Satellite system and their functions (structure, thermal, mechanisms, power, propulsion, guidance and control, bus electronics).

UNIT II	**ORBITAL MECHANICS**	**9**

Fundamental of flight dynamics – Time and coordinate systems – Orbit determination and prediction – Orbital maneuvers – GPS systems and application for satellite/orbit determination – Ground station network requirements.

UNIT III	**SATELLITE STRUCTURES & THERMAL CONTROL**	**9**

Satellite mechanical and structural configuration: Satellite configuration choices, launch loads, separation induced loads, deployment requirements – Design and analysis of satellite structures – Structural materials and fabrication – The need of thermal control: externally induced thermal environment – Internally induced thermal environment - Heat transfer mechanism: internal to the spacecraft and external heat load variations – Thermal control systems: active and passive methods.

UNIT IV	**SPACECRAFT CONTROL**	**9**

Control requirements: attitude control and station keeping functions, type of control maneuvers – Stabilization schemes: spin stabilization, gravity gradient methods, 3 axis stabilization – Commonly used control systems: mass expulsion systems, momentum exchange systems, gyro and magnetic torque - Sensors star and sun sensors, earth sensor, magnetometers and inertial sensors

UNIT V	**POWER SYSTEM AND BUS ELECTRONICS**	**9**

Solar panels: Silicon and Ga-As cells, power generation capacity, efficiency – Space battery systems – battery types, characteristics and efficiency parameters – Power electronics. Telemetry and telecommand systems: Tm & TC functions, generally employed communication bands (UHF/VHF, S, L, Ku, Kaetc), their characteristics and applications- Coding Systems – Onboard computer- Ground checkout Systems.

Text Books:

1. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.
2. Introduction Space Flight, Francis J. Hale Prentice Hall, 1994.

References:

1. Analysis and Design of Flight Vehicle Structures, Tri-State off set company, USA, 1980.
2. Space Systems Engineering Rilay, FF, McGraw Hill, 1982.
3. Principles of Astronautics Vertregt. M., Elsevier Publishing Company, 1985
4 .Space Communications Systems, Richard.F, FilipowskyEugen I Muehllorf Prentice Hall, 1995
5. Space Vehicle Design, Michael D. Griffin and James R. French, AIAAEducation Series, 1991.

BANE22	**AIRCRAFT RULES AND REGULATIONS CAR I & II**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Professional Courses				

	Course Designed by – Department of Aeronautical Engineering

OBJECTIVES

1. To familiarize the student about the CAR series A & B
2. To familiarize the student about the CAR series C & D
3. To familiarize the student about the CAR series E & F
4. To familiarize the student about the CAR series L & M
5. To familiarize the student about the CAR series T & X

COURSE CONTENT

UNIT I	**C.A.R. SERIES "A " & " B "**	**9**

C.A.R series 'A' - procedure for civil air worthiness Requirements and responsibility operators vis-a-vis Air Worthiness directorate - Responsibilities of operators/owners; procedure of CAR issue, amendments etc; objectives and targets of airworthiness directorate; airworthiness regulations and safety oversight of engineering activities of operations.

C.A.R. series "B" – issue approval of cockpit check list, MEL, CDL - Deficiency list (MEL & CDL); preparation and use of cockpit check list and emergency check list.

UNIT II	**C.A.R. SERIES "C " & " D "**	**9**

C.A.R. series 'C' - defect recording, monitoring, investigation and reporting - Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-fight readings & recordings; Maintenance control by reliability Method.

C.A.R. series 'D'-aircraft maintenance programmes - Reliability Programme (Engines); Aircraft maintenance programme& their approval - On condition maintenance of reciprocating engines; TBO - Revision programme; Maintenance of fuel and oil uplift and consumption records - Light aircraft engines; Fixing routine maintenance periods and component TBOs - Initial & revisions.

UNIT III	**C.A.R. SERIES "E" & " F "**	**9**

C.A.R. series 'E' - approval of organizations - Approval of organizations in categories A, B, C, D, E, F, & G; Requirements of infrastructure at stations other than parent base.

C.A.R. series 'F' - air worthiness and continued air worthiness - Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness

UNIT IV	**C.A.R. SERIES "L " & " M "**	**9**

C.A.R. series 'L' - aircraft maintenance engineer – licensing - Issue of AME License, its classification and experience requirements, Complete Series 'L'.

C.A.R. series 'M' Mandatory Modifications / Inspections.

UNIT V	**C.A.R. SERIES "T " & " X "**	**9**

C.A.R. series 'T' - flight testing of aircraft - Flight testing of (Series) aircraft for issue of C of A; Fight testing of aircraft for which C or A had been previously issued.

C.A.R. series 'X' - miscellaneous requirements - Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of taxy permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

Text Books:

1. " Aircraft Manual (India) ", The English Book Store, 17-1, Connaught Circus, New Delhi.

References:

1. " Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness) ", Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi.
2. "Aeronautical Information Circulars (relating to Airworthiness) ", from DGCA.Advisory Circulars ", form DGCA.

OPEN ELECTIVE-I

BBA001	**PRINCIPALS OF MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Professional Courses				
	Course Designed by – Department of Management Studies				

OBJECTIVES

1. To acquaint the student about the management, various types of management function and structure.
2. To give insight of various methods of management of organization and managerial aspects.
3. To acquaint the student with various functions of organizational behavior.
4. To get exposure regarding its applications and recent developments of group dynamics and trade union
5. To help the student understand about the professional ethics and social responsibilities.

COURSE CONTENT

UNIT I	**NATURE OF MANAGEMENT**	**9**

Definition – theory and practice – effective management – Management : Science of Art – Management in India. Development of Management thoughts – Taylor's – Henry Fayol – Hawthrone experiment – Barnard & Social system – Herbert Simon – Peter Drucker – Various approaches – Management thoughts.

UNIT II	**MANAGEMENT PROCESS**	**9**

Co-ordination – Functions of management – Managers and environment – External and internal Business Ethics – Planning – Fundamentals – Definitions & Features – Steps in planning – types of planning – Objectives – Concepts and features – Hierarchy of objectives – role – Process of MBO – Policy & Strategy – Decision making process – Individual Vs Group Decisions.

UNIT III	**ORGANIZATION STRUCTURE**	**9**

Organizing – Theory & Approach –Authority & Responsibility – Delegation – Centralization & Decentralization – Line & Staff Relationship – Staffing – Fundamentals – System approach – Manpower Planning – Recruitment & Selection – Training and development – Performance appraisal – Direction – Fundamentals Motivation – Theories of Motivation-Maslow's Hersberg'sMaClelland's theory X,Y & Z leadership – Theories and Styles – Communication – Type – Controlling – System and Process.

UNIT IV	**ORGANIZATIONAL BEHAVIOUR**	**9**

Definition – Organization – Managerial Role and Functions – Organizational Approaches, Individual behaviour – Causes – Environmental effect – Behaviour and performance, perception – Organizational implications, Personality – Contributing factors – Dimension, Motivation – Need Theories – Process Theories – Job satisfaction, Learning and Behaviour – Learning Curves, Work Design and Approaches.		
UNIT V	**GROUP BEHAVIOUR**	**9**
Groups – Contributing factors –Group Norms, types – Causes – Intergroup relations – Conflict and Resolution – Change Process –Resistance to change.		

Text Books:

1. Herald Knootz and Heinz weihrich, 'Essentials of Management', McGraw Hill Publishing Company, Singapore International Edition, 2004.
2. Ties AF, Stoner and R. Edward Freeman, "Management" Prentice Hall of India Pvt. Ltd., New Delhi -110011, 1995..

References:

1. Joseph I. Massie 'Essentials of Management', Prentice Hall of India Pvt. Ltd., New Delh-110011, 2004.
2. L.M. Prasad "Principles and Practice of Management", Sultan Chand & Sons.2001
3. Uma Sekaran, "Organizational Behaviour", Tata McGraw Hill, 2007
4. https://www.extension.harvard.edu1

BANE23	**AIRPORT MANAGEMENT**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Professional Courses				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce to the student about air transportation, various organizations involved and about the administrative structure in aviation.
2. To accustom the student about economic parameters in an aviation industry.
3. To introduce to the student about the processes involved in airline scheduling.
4. To acquaint the student about the various processes to ensure aircraft reliability.
5. To familiarize the student about the technologies used in aircraft maintenance.

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9**
Development of air transportation, comparison with other modes of transport – Role of IATA, ICAO – The general aviation industry airline – Factors affecting general aviation, use of aircraft, airport: airline management and organization – levels of management, functions of management, Principles of organization planning the organization – chart, staff departments & line departments.		
UNIT II	**AIRLINE ECONOMICS**	**9**

Forecasting – Fleet size, Fleet planning, the aircraft selection process, operating cost, passenger capacity, load factor etc. – Passenger fare and tariffs – Influence of geographical, economic & political factors on routes and route selection.
Fleet Planning: The aircraft selection process – Fleet commonality, factors affecting choice of fleet, route selection and Capitol acquisition – Valuation & Depreciation – Budgeting, Cost planning – Aircrew evaluation – Route analysis – Aircraft evaluation.

UNIT III	PRINCIPLES OF AIRLINES SCHEDULING	9

Equipment maintenance, Flight operations and crew scheduling, Ground operations and facility limitations, equipments and types of schedule – hub & spoke scheduling, advantages / disadvantages & preparing flight plans – Aircraft scheduling in line with aircraft maintenance practices.

UNIT IV	AIRCRAFT RELIABILITY	9

Aircraft reliability – The maintenance schedule & its determinations – Condition monitoring maintenance – Extended range operations (EROPS) & ETOPS – Ageing aircraft maintenance production.

UNIT V	TECHNOLOGY IN AIRCRAFT MAINTENANCE	9

Airlines scheduling (with reference to engineering) – Product support and spares – Maintenance sharing – Equipments and tools for aircraft maintenance – Aircraft weight control – Budgetary control.
On board maintenance systems – Engine monitoring – Turbine engine oil maintenance – Turbine engine vibration monitoring in aircraft – Life usage monitoring – Current capabilities of NDT – Helicopter maintenance – Future of aircraft maintenance.

Text Books:

1. FEDRIC J.H., "Airport Management", 2000.
2. C.H. FRIEND, "Aircraft Maintenance Management", 2000.

References:

1. Gene Kropf, "Airline Procedures".
2. Wilson & Bryon, "Air Transportation".
3. Philip Locklin D, "Economics Of Transportation".
4. "Indian Aircraft Manual" – Dgca Pub.
5. Alexander T Wells, "Air Transportation", Wadsworth Publishing Company, California, 1993

BANE24	AEROSPACE BIO – MEDICAL AND LIFE SUPPORT ENGINEERING	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Basic Electrical and Electronics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To apply engineering methods to the study of astronaut adaptation to reduced gravity environments.
2. To use analytical techniques, such as structural idealizations, control theory, electrical circuit, and mechanical system analogs to model astronaut performance.
3. To enable quantitative assessment of the effectiveness of countermeasures.
4. To consider the socio-political implications for advanced technological R&D (e.g., space policy, health policy, international collaboration).
5. To teach, perform outreach, and demonstrate mastery of a chosen engineering concept.

COURSE CONTENT		
UNIT I	**INTRODUCTION**	**9**
Physiological problems associated with human space flight – review of terminologies		
UNIT II	**BIO – MECHANICS IN SPACE FLIGHT**	**9**
Bone Mechanics, Muscle Mechanics, Musculoskeletal Dynamics, and the Cardiovascular System during space flight – their equations of motion		
UNIT III	**BIO – MECHANICAL MODELING**	**9**
Structural idealizations – mechanical and electrical modeling of muscle groups – musculoskeletal groups – joints, electrical analogies to model astronaut performance		
UNIT IV	**LIFE SUPPORT SYSTEMS**	**9**
Onboard environment control systems – waste product management and recycling system – bio – monitoring and control		
UNIT V	**EXTRA – VEHICULAR ACTIVITY**	**9**
Extra Vehicular activity – challenges – specialties of space suits – life support system for EVA		

Text Books:

1. "Space Physiology", Beckers, Frank, Bart Verheyden, Andre E Aubert, Wiley Encylopaedia of Bio – medical engineering, John Wiley and Sons, Inc., 2006
2. "Fundamentals of Space Life Sciences", Diamandis, Peter H. Edited by Susanne Churchill. Malabar, FL: Krieger Publishing Co., 1997.

References:

1. "Human Anatomy Manual: The Skeleton", Gatesville, TX, Medical Plastics Laboratory, Inc., 1997
2. Gomi, Hiroaki, and MitsuoKawato. "Equilibrium-Point Control Hypothesis Examined by Measured Arm Stiffness during Multijoint Movement." Science 272, no. 5258 (1996): 117-120.
3. Aubert, A.E., F. Beckers, and B. Verheyden. "Cardiovascular Function and Basics of Physiology in Microgravity." ActaCardiol 60, no. 2 (2005): 129-151.
4. Flash, T. "The Control of Hand Equilibrium Trajectories in Multi-joint Arm Movements." Biological Cybernetics 57 (1987): 257-274.
5. Bizzi, E., W. Chapple, and N. Hogan. "Mechanical Properties of Muscles: Implications for Motor Control." Trends in Neurosciences 5, no. 11 (1982): 395-398.
6. Shenkman, Boris S., and Inessa B. Kozlovskaya. "Results of Studies of the Effects of Space Flight Factors of Human Physiological Systems and Psychological Status, and Suggestions of Future Collaborative Activities between the NSBRI and the IBMP." Section 3: Muscles. State Research Center of Russian Federation Institute for Biomedical Problems Report, Moscow, 2000.
7. Stuster, J., C. Bachelard, and P. Suedfeld. "The Relative Importance of Behavioral Issues during Long-duration ICE Missions." Aviat. Space Env. Med. (September 2000): A17-A25.
8. Brubakk, A. "Man in Extreme Environments." Aviat. Space Env. Med. (September 2000): A126-A130.

OPEN ELECTIVE-II

BBA008	**TOTAL QUALITY MANAGEMENT**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3

	Prerequisite – Professional Courses
	Course Designed by – Department of Management Studies

OBJECTIVES

1. To introduce to the student about the basic terms related to quality and concepts of quality management
2. To familiarize the student about the basic principles of total quality management
3. To acquaint the student with the basic statistical tools used in process control
4. To introduce to the student about the various tools used in implementing and checking total quality management
5. To familiarize the student about the different quality systems used in auditing the quality of a company/industry/organization

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9**

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT II	**TQM PRINCIPLES**	**9**

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership –Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

UNIT III	**STATISTICAL PROCESS CONTROL (SPC)**	**9**

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT IV	**TQM TOOLS**	**9**

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA –Stages of FMEA.

UNIT V	**QUALITY SYSTEMS**	**9**

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System –Elements, Implementation of Quality System, Documentation, Quality Auditing, TS16949, ISO 14000 – Concept, Requirements and Benefits.

Text Books:

1. Dale H. Besterfiled, et al., "Total Quality Management", Pearson Education, Inc.2003. (Indian reprint 2004). ISBN 81-297-0260-6.

References:

1. Evans. J. R. & Lindsay. W,M "The Management and Control of Quality", (5th Edition),South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).
2. Feigenbaum.A.V. "Total Quality Management", McGraw-Hill, 1991.
3.Oakland.J.S. "Total Quality Management", Butterworth Hcinemann Ltd., Oxford,1989.
4. Narayana V. and Sreenivasan, N.S. "Quality Management – Concepts and Tasks",New Age

International 1996.
5. Zeiri. “Total Quality Management for Engineers”, Wood Head Publishers, 1991.

BANE25	INDUSTRIAL AERODYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aerodynamics I				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1.To introduce to the student about the aerodynamics taking place in the atmosphere
2. To familiarize the student about the aerodynamics of flow over bluff bodies and its effect on those bodies
3. To acquaint the student about the various mechanisms and procedures by which energy can be extracted from the wind
4. To accustom the student about the aerodynamics of flow around buildings, towers and bridges and also about ventilation and architectural aerodynamics
5. To familiarize the student about the loads on a structure due to wind and the resulting vibrations and their calculations

COURSE CONTENT

UNIT I	ATMOSPHERIC BOUNDARY LAYER	9

Atmospheric circulation-Local winds-Terrain types-Mean velocity profiles-Power law and logarithm law-wind speeds-Turbulence profiles-Roughness parameters-simulation techniques in wind tunnels

UNIT II	BLUFF BODY AERODYNAMICS	9

Boundary layers and separation-Two dimensional wake and vortex formation-Strouhal and Reynolds numbers-Separation and reattachments-Power requirements and drag coefficients of automobiles-Effects of cut back angle-aerodynamics of trains.

UNIT III	WIND ENERGY COLLECTORS	9

Horizontal and vertical axis machines-energy density of different rotors-Power coefficient-Betz coefficient by momentum theory.

UNIT IV	BUILDING AERODYNAMICS	9

Pressure distribution on low rise buildings-wind forces on buildings-Environmental winds in city blocks-special problems of tall buildings-building codes-ventilation and architectural aerodynamics

UNIT V	FLOW INDUCED VIBRATIONS	9

Vortex shedding, lock & effects of Reynolds number on wake formation in turbulent flows- across wind galloping-wake galloping-along wind galloping of circular cables-oscillation of tall structures and launch vehicles under wind loads-stall flutter.

Text Books:

1. Blevins R.D “Flow Induced Vibrations”, Van Nostrand, 1990
2.Sovran, M(ed) “Aerodynamic drag mechanism of bluff bodies and road vehicles”,Plenum Press, N.Y, 1990

References:

1. Sachs P "Wind Forces in Engineering", Pergamon Press, 1988
2. Scorer R.S "Environmental Aerodynamics", Ellis Harwood Ltd, England, 1978
3. Calvert N.G "Wind Power Principles", Charles Griffin & Co London, 1979.

BANE26	MECHANICS OF HETEROGENEOUS MATERIALS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Engineering Physics I, Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce to the student about the various heterogeneous materials.
2. To accustom the student to the mechanics of heterogeneous materials.
3. To acquaint the student to the structure of particulate, fibrous and cellular solids and their properties.
4. To familiarize the student about the hierarchical structure in heterogeneous materials.
5. To enable the student to understand various design considerations in application of heterogeneous materials.

COURSE CONTENT

UNIT I	INTRODUCTION	9

Material heterogeneity. Survey of laminated, fibrous, particulate, cellular and porous, platelet structures. Single crystal properties and polycrystal properties. Heterogeneity of biological materials and designed heterogeneity. Strength of fibers. Constituent materials. Griffith's experiments, stress concentrations. Concept of equivalent homogeneity. Micro and nanotructures.

UNIT II	STRUCTURE OF HETEROGENEOUS MATERIALS	9

Unidirectional fibrous media. Bounds on physical properties: Voigt and Reuss bounds; Hashin-Shtrikman. Prediction of stiffness and strength for different directions. Symmetry and physical properties. Crystal symmetry classes. Generalized Hooke's law of elasticity. Modulus and compliance matrices. Anisotropy and dielectric and piezoelectric properties. Thermal expansion. Experimental methods.

UNIT III	PARTICULATE, FIBROUS AND CELLULAR SOLIDS	12

Structure. Particulate materials. Dental composites, metal matrix composites, asphalt. Toughened polymers via compliant inclusions. Stiffness vs. volume fraction. Self healing polymers. Attainment of the Hashin-Shtrikman bounds. Unidirectional fibrous materials; stiffness, strength, thermal expansion. Fibrous solids with short-fibers. Nano-tubes as fibers. Platelet reinforcement. Shear lag model. Laminates. Polycrystalline aggregates. Piezoelectric composites. Metal matrix composites. Structure property relations of cellular solids. Lightweight cellular solids. Foams, structural honeycombs, sandwich structures. Polymer lattice structures. Syntactic foams. Poisson's ratio of composites and foams. Applications.

UNIT IV	HIERARCHICAL STRUCTURE	6

Structure within structure. Bone, wood, tendon and other materials of biological origin. Fibrous aspects of bone structure. Tendon and ligament as fibrous biological materials. Biological cellular solids. Cellular architecture of bone, wood, bamboo.

UNIT V	DESIGN CONSIDERATIONS	9

Fracture mechanics, stress concentrations, free-edge effects. In situ composites; eutectic structure. Gradient effects. Role of microstructure size. Generalized continuum models; Cosserat elasticity. Toughness: empirical criteria; causal mechanisms. Spongy impact absorber, bone cement.
Text Books: 1. L. J. Gibson, and M. F. Ashby, Cellular Solids, Cambridge, (1999). 2. M. F. Ashby and D. R. H. Jones, Engineering Materials, 2nd ed. Butterworth, (1998).
References: 1. J. F. Nye, Physical Properties of Crystals, Oxford, (1976). 2. B. D. Agarwal and L. J. Broutman, Analysis and Performance of Fiber Composites, J. Wiley, 2nd ed. (1990).