MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

SYLLABUS

MSc/M ENGG IN
AERONAUTICAL ENGINEERING

AERONAUTICAL ENGINEERING

REVISED ON JANUARY 2020

DEPARTMENT OF AERONAUTICAL ENGINEERING (AE)
MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY (MIST)
MIRPUR CANTONMENT, DHAKA-1216, BANGLADESH

PROCEEDINGS OF THE COMMITTEE OF COURSES FOR FORMULATING COURSE CURRICULUM FOR THE POSTGRADUATE DEGREE PROGRAMME IN AERONAUTICAL ENGINEERING

The Committee or courses for formulating the course curriculum for the postgraduate degree program in Aeronautical Engineering to be conducted by Department of Aeronautical Engineering (AE) Military Institute of Science and Technology (MIST) published vide Bangladesh University of Professional (BUP) letter number 23.01.902.858 10.786.03.01.10.19 dated 01 October 2019. The understand committee has worked out and finalized the detailed course outline for the aforementioned postgraduate degree program on _____ January 2020.

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6. Brigadier General Md Zahidur Rahim, ndc, afwc, psc
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7. Wing Commander Asaduzzaman (Retd.)
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CHAPTER 1

INTRODUCTION TO MIST AND AERONAUTICAL ENGINEERING DEPARTMENT, MIST

1.1 General Information of MIST

The necessity of establishing a technical institute for the Bangladesh Armed Forces was felt in the late eighties. In the absence of such an institution, officers of Bangladesh Armed Forces had been graduating from Bangladesh University of Engineering and Technology (BUET), Bangladesh Institute of Technology (BIT) and other foreign institutions of science and technology. With a view to meet the increasing demand for the development and dissemination of engineering and technological knowledge, Bangladesh Armed Forces established the Military Institute of Science and Technology (MIST) that promises to provide facilities for higher technical education both for the officers of Bangladesh Armed Forces as well as for civil students from home and abroad. The motto of MIST is Technology for Advancement. Founded on 19 April 1998, MIST started its journey on 31 January 1999 by offering a four-year bachelor's degree on Civil Engineering. Bachelor degree on Computer Science Engineering course started on 2001**.** Bachelor courses on Electrical, Electronic & Communication Engineering and Mechanical Engineering started its journey from 2003. Bachelor of Science program on Aeronautical Engineering (AE) and Naval Architecture and Marine Engineering (NAME) program were started from 2008-2009 and 2012-2013 respectively. Besides, four new departments started their academic session from 2014-2015 i.e. Nuclear Science & Engineering (NSE), Biomedical Engineering (BME), Architecture (Arch) and Environmental, Water Resources & Coastal Engineering (EWCE).

1.2. Introduction to the Aeronautical Engineering program

In view of global necessity, it is clear that postgraduate degree in aeronautical engineering will play an important role to meet the future demand of highly professional individuals in this field. The national and international requirement of professionals in the field of aeronautical engineering is increasing day by day both in developing and developed countries. From this perspective, it is of

vital importance to offer post graduate level high quality education to the next generation of aeronautical engineers.

The Master's program in aeronautical engineering offers students deep knowledge and functional skills in most fields of relevance for aeronautical technology. After graduation, students will be well prepared for future positions within the advanced professional arena, or in an Aeronautical technology research environment.

1.3. Vision and Mission of Aeronautical Engineering Department:

Vision: To be a part of an internationally recognized center of excellence for providing quality education in the field of Aeronautical Engineering and to conduct research to meet the national and global challenges.

Mission

1. To produce Engineers and researchers with sound knowledge on Fundamentals of traditional, modern and emerging areas of Aeronautical Engineering.

2. To achieve professional knowledge of aircraft design and maintenance along the innovative design research abilities and managerial skills, which are essential for sustainable national and global development.

3. To provide aviation related consultancy and promote student an awareness of the life-long learning and work as part of teams on disciplinary projects.

4. On 16 November 2015, in the 15th Meeting of Council of MIST, it was decided that a board of officers should study the feasibility of running Post Graduate Programme in AE from April 2016 semester. According to the positive recommendation of the board and committee of courses (formed with distinguished professors from BUET and in house faculties of MIST) M.Sc/M.Engg programme was started from April 2016 semester and Ph.D programme was started from April 2016 semester. In the designed curricula, maximum courses were included providing wider opportunities for the students in selecting courses. However, considering the advancement of technology, existing curricula need to be updated and new courses are to be included.

1.4. Facilities of the Department

The department endeavors to provide its faculty members and students adequate laboratory, library and other facilities. The departmental graduate courses are laboratory intensive and these requirements are catered for by following laboratories.

a. Labs available in AE Dept

(1) Applied Aerodynamics Lab

(2) Aero-structure Lab

(3) Propulsion (Aero-engine) Lab

(4) Avionics and Ground Electronics Lab

(5) Radar Engineering Lab

b. Labs support from other Dept of MIST

(1) Aero-Fluid Mechanics and Machinery Lab

(2) Temperature Control and Heat Transfer Lab

(3) Pressurization & Air Conditioning Lab

(4) Controls (Mechatronics) Lab

(5) Machine Tools Lab

(6) Test and Measurement Lab

(7) CAD (Computer Aided Design) Lab

(8) Aero-Electrical and Electro-Mechanical Lab

(9) Microwave Communication Lab

(10) Digital Signal Processing (DSP) Lab

c. <u>Future plan in AE Dept</u>

(1) Life Saving Equipment Lab

(2) Aerospace Ground Equipment Lab

(3) Aero-Composite Material Lab

(4) Aero-Non-Destructive Testing and Evaluation (NDTE) Lab

(5) Airborne Electronics Lab

(6) Electronic Warfare (EW) & Stealth Technique Lab

(7) Aero-Satellite Communication & Remote Sensing Lab

(8) Aero-Weapon System Lab

(9) Aero Control (Dynamic Stability) Engineering Lab

(10) Aero-Instrumentation (Avionics) Lab

(11) Sensor & Guidance Lab

CHAPTER 2

RULES AND REGULATIONS FOR MASTERS DEGREE

2.1 Degrees Offered

The Masters degrees to be offered under the Post-Graduation Ordinance of MIST in ME Department are as follows:

2.1.1	**Master of Science in**		
Aeronautical Engineering, Abbreviated as			M.Sc. Engg. (AE)
2.1.2	**Master of Engineering in**		
Aeronautical Engineering, Abbreviated as			M. Engg. (AE)

2.2. Program Objectives / Program Educational Objectives (PEO)

Based on the suggestion of Board of Accreditation for Engineering and Technical Education (BAETE), Bangladesh, the Bachelor in Aeronautical Engineering (AE) program will have following learning outcomes:

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

b. Problem analysis: Identify, formulate, research the literature and analyze complex engineering problems and reach substantiated conclusions using first principles of mathematics, the natural sciences and the engineering sciences.

c. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns.

d. **Investigation:** Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

e. **Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

f. **The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

g. **Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

h. **Ethics:** Apply ethical principles and commit to professional ethics, responsibilities and the norms of the engineering practice.

i. Individual work and teamwork: Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings.

j. Communication: Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions

k. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multidisciplinary environments.

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

2.3. Learning Outcomes/Program Outcomes (PO)

Mentioned in the detailed course profile

2.3.1. Generic Skills

For admission to the courses leading to a Master's degree (M.Sc. Engg. / M. Engg.) an applicant:

a. Must have a minimum GPA of 4.00 out of 5.00 or a first division or equivalent in S. S. C and H. S. C or in equivalent examinations;

b. Must have obtained a B.Sc. Engg. Degree in Aeronautical Engineering or related equivalent engineering degree from any UGC recognized university/institution. The duration of B. Sc. Engg. or equivalent degree program should be of minimum four (04) years, and the applicant must have at least 55% marks or a minimum GPA of 2.75 out of 4.0 or its equivalent in the under-graduation programme;

c. In case of different grading system, the GPA of all the above examinations should be evaluated by the MIST Equivalence Committee.

d. In case of difference in the under-graduation degree, the applicant may require to undertake prerequisite theory course(s) as allocated by the BPGS of AE department to achieve the equivalency amongst the candidates.

2.3.1.1 For admission to the courses leading to the degree of M.Sc. Engg. /M.Engg. in any branch, an applicant must have obtained a B.Sc. Engg. Degree in the relevant branch or an equivalent degree from any UGC recognized institution. For the case of non-relevant degree of a department, the candidate may be required to undertake prerequisite courses as determined by the BPGS of that department.

2.3.1.2 For any course requiring any prerequisite knowledge, will be mentioned in that respective course profile.

2.4. Curriculum/ Skill mapping

Mentioned in the detailed course profile

2.5. Detail Outlines of Postgraduate Courses Offered by Department of AE, MIST

The courses offered by the Department for Masters Programsare generally divided in the following divisions.

Aerospace Discipline

a. Division of Aerodynamics

b. Division of Aero-Structure

c. Division of Aircraft Propulsion and Engine Systems

d. Division of Aerospace Materials

e. Division of Space and Aerospace Vehicle Design

Avionics Discipline

a. Division of Navigation, Guidance and Controls

b. Division of Communications and Microwave Engineering

The following courses are offered by the Department for Masters Programs. In each term, only some of the courses (typically 6-9credits) are offered from the different divisions.

Course No.	Course Title	Credit Hours
General Courses		
AE 6000*	Thesis(M. Sc. Engg.)	18
	Project (M. Engg)	6
AE 6001*	Seminar	Non credit
AE 6107*	Research Methods for Engineers	Non credit
AE 6102	Advanced Numerical Analysis	3
AE 6003	Advanced Engineering Mathematics	3
AE 6004	Advanced Partial Differential Equations	3
AE 6105	Human Factors Engineering and Ethics	3
AE 6106	Management for Technology	3
AE 6108	Advanced Weapon Engineering	3 (Only for military students)
ME 6251	Advanced Automobile Engineering	3 (Compulsory for EME officers)
EECE 6907	Advanced Electrical, Electronic and Communication Engineering	3 (Compulsory for EME officers)

Aerospace Discipline:		
a. Division of Aerodynamics		
AEAS 6111	Advanced Incompressible Fluid Dynamics	3

AEAS 6112	Advanced Compressible Fluid Dynamics	3
AEAS 6113	Turbulent Fluid Flow and Turbulence Modeling	3
AEAS 6114	Rotorcraft Aerodynamics	3
AEAS 6115	Computational Fluid Dynamics I	3
AEAS 6116	Computational Fluid Dynamics II	3
AEAS 6117	Flight Dynamics and Control	3
AEAS 6118	Potential Flow and Panel Method	3
AEAS 6119	Experimental Techniques in Fluid and Thermal Sciences	3
AEAS 6120	Hypersonic/High Temperature Gas Dynamics	3
AEAS 6121	Rarefied Gas Dynamics / Kinetic Theory	3
AEAS 6122	Advanced Heat Transfer	3
AEAS 6123	Advanced Hydrodynamic Stability	3
b. Division of Aero-Structure		
AEAS 6131	Advanced Aircraft Structures	
AEAS 6132	Advanced Theory of Vibrations	3
AEAS 6133	Design and Analysis of Composites	3
AEAS 6134	Finite Element Methodsand Analysis	3
AEAS 6135	Tribology	3
AEAS 6136	Advanced Theory of Elasticity	3
AEAS 6137	Loading Actions	3
AEAS 6138	Design for Manufacture and Operation	3
AEAS 6139	Fatigue Fracture Mechanics and Damage Tolerance	3
AEAS 6140	Advanced Aero-Elasticity	3
AEAS 6141	Theory of Plates and Shells	3
AEAS 6142	Thin Walled Structures	3
AEAS 6143	Fracture Mechanics	3
c. Division of Propulsion and Engine Systems		
AEAS 6151	Gas Turbine Theory and Performance	3
AEAS 6152	Propulsion Systems Performance and Integration	3
AEAS 6153	Jet Engine Control	3
AEAS 6154	Blade Cooling	3
AEAS 6155	Combustors	3
AEAS 6156	Engine Systems	3
AEAS 6167	Aerospace Rotating Equipment Selection	3
AEAS 6158	Advanced Turbo-Machinery	3
AEAS 6159	Gas Turbine Simulation and Diagnostics	3
AEAS 6160	Gas Turbine Applications	3
		3
d. Division of Aerospace Materials		
AEAS 6171	Advanced Materials in Engineering	3
AEAS 6172	Advanced Strength of Materials	3
AEAS 6173	Aerospace Materials Processing and Performance	3
AEAS 6174	Composites Manufacturing for High Performance	3

	Products	
AEAS 6175	Functional Materials	3
AEAS 6176	Failure of Materials and Structures	3
AEAS 6177	Surface Science and Engineering	3
AEAS 6178	Aerospace Materials Selection	3
AEAS 6179	Polymer Engineering	3
AEAS 6180	Degradation of Materials	3
e. Division of Space and Aerospace Vehicle Design		
AEAS6191	Advanced Aircraft Designing and Optimization	3
AEAS6192	Advanced Aircraft Stability and Control	3
AEAS6193	Advanced Aircraft Performance	3
AEAS6194	Aircraft Accident Investigation	3
AEAS6195	Reliability, Safely Assessment and Certification	3
AEAS6196	Crashworthiness	3

Avionics Discipline:		
a. Division of Aircraft Navigation, Guidance and Controls		
AEAV6211	Inertial & Satellite Navigation System	3
AEAV6212	Integrated Navigation System	3
AEAV6213	Missile Guidance	3
AEAV6214	Flight Dynamics and Control	3
AEAV6215	Linear Systems Theory	3
AEAV6216	Probability and Random Processes	3
AEAV6217	Advanced Control system	3
AEAV6218	Cockpit Environment	3
AEAV6219	Instrumentation and Measurement for Aerospace Applications	3
b. Division of Aircraft Communication, Signal Processing and Microwave Engineering		
AEAV6231	Signal Analysis and Processing	3
AEAV6232	Image Analysis and Processing	3
AEAV6233	Advanced Antenna Theory and Design	3
AEAV6234	Satellite Communication System	3
AEAV6235	Advanced Digital Communications	3
AEAV6236	Radio Communication Systems	3
AEAV6237	Advanced Digital Signal Processing	3
AEAV6238	Detection and Estimation	3
AEAV6240	Fault tolerant Avionics Design	3
AEAV6241	Advanced Electromagnetic Field Theory	3
AEAV6242	Advanced Radar Engineering	3
AEAV6243	Microwave Devices and Circuits Design	3

AEAV6244	Transmission Line and Waveguides	3
AEAV6245	Advanced Wireless Communications	3

2.6. Course Schedule

All students must complete at least two courses (6 credit) in his/ her respected area of research. The regulations for registering courses and forming different committees are as follows:

2.6.1 Admission and Registration Procedures

2.6.1.1 Applications for admission to the above programs shall be invited through regular means of advertisement and shall be received by the Admission officer.

2.6.1.2 Before being finally selected for admission, an applicant may be required to appear at an oral and/or written test by a Selection Committee as constituted by the concerned department. Every selected applicant, unless he/she has already been registered, shall get himself/herself registered with Bangladesh University of Professionals (BUP).

2.6.1.3 After admission each student shall be assigned, by the Head of the department, an Adviser from among the teachers of the Department not below the rank of an Associate Professor/Instructor Class A. In advance of each enrolment and registration, the Adviser shall check and approve his/her student's schedule for subjects, pre-requisites as recommended by the Selection Committee and the total hours. The student is expected to consult his/her Adviser on all academic matters but, it is the responsibility of the individual student to see that his/her schedule conforms to the academic regulations. If no advisor is assigned, then the student will contact with the Postgraduate Program Coordinator or Head of the department for all academic matters.

2.6.1.4 Every registered student shall get himself/herself enrolled on payment of prescribed fees and other dues as per MIST and BUP rules before commencement of each semester.

2.6.1.5 On the recommendation of the Board of Post Graduate Studies (BPGS) and Committee for Advanced Studies and Research (CASR), the rules for admission into the post graduate studies shall be framed from time to time by the Academic Council. CASR on its own may, if it deems fit, recommend such rules for admission for approval of the Academic Council. The composition of BPGS and CASR is mentioned in page 4 of this ordinance.

2.6.1.6 No late registration will be allowed after two weeks of designated dates of registration. Late registration after this date may only be accepted for thesis/project if the student submits a written appeal to the Dean, MIST through the concerned Head and can document extenuating circumstances such as medical problems (physically incapacitated and not able to be presented) from the Medical Officer (MO) of the Institute or some other academic commitments which precluded registration prior to the last date of registration. Students will be charged a late registration fee of Tk. 1000.00 (One thousand) only. This extra fee will not be waived whatever be the reason for late registration.

2.6.1.7 If a student is unable to complete the final examination of a semester due to serious illness or serious accident or official commitment he/she may apply to the Dean, MIST in a prescribed form through Head/Director of the Department for total withdrawal from the semester within a week after the end of the semester final examination. The application must be supported by a medical certificate from the MO, or relevant Official documents. The Academic Council will take the final decision about such application on the recommendation of the relevant BPGS.

2.6.2. Supervisor

2.6.2.1 Criteria of supervisor selection

On admission and fulfillment of other requirements as mentioned in this ordinance, the Head or Postgraduate Program Coordinator of the relevant department will suggest a Supervisor for the student after completion of at least 60% theory courses with minimum required CGPA (for MSc: 3.00 and for MEngg: 2.75) following the format as given in Annexure-1. Without taking supervisor a student is not allowed to register credit hours for thesis/project. The criteria of supervisor are as follows:

2.6.2.1.1 He/She must have a PhD degree in a relevant discipline from any public university of Bangladesh/renowned foreign university.

2.6.2.1.2 Scrutinising of the PhD degree has to be done through a committee as comprised below before selection as a supervisor:
- Head of the concern department
- One teacher from MIST
- One external member

2.6.2.1.3 He/She should have at least 01 years of postgraduate teaching and supervising experience or 02 years of research experience from any public university or from national/internationally renowned research organization.

2.6.2.1.4 Any person who has online PhD will not be appointed as supervisor.

2.6.2.1.5 Any person who fulfills above criteria and preferably has 02 publications in reputed peer reviewed journals as a First/Corresponding author will be appointed as a supervisor.

2.6.2.1.6 The institute may outsource supervisors primarily from public university on fulfillment of above criteria. However, a retired teacher of public university presently serving in any other organization/university may be permitted to supervise on fulfillment of above criteria.

2.6.2.1.7 The BPGS will look into the fulfillment of the above criteria before appointing supervisors. Approval of CASR for appointing supervisor must be taken.

2.6.2.1.8 If supervisor is selected outside of this institute, CASR through BPGS may decide whether a co-supervisor from MIST is required or not.

2.6.2.1.9 If co-supervisor is required for a particular thesis work, the co-supervisor preferably should have a PhD degree from reputed university, however, a faculty member holding MSc (with thesis) degree can work as a co-supervisor.

2.6.2.1.10 For MEngg projects a faculty member holding MSc (with thesis) degree with at least 02 years of teaching and/or research experience may be permitted to supervise.

2.6.2.1.11 A supervisor/co-supervisor shall not take more than 12 (twelve) students (maximum 6 as supervisor and remaining 6 as co-supervisor) of two programs ie Masters and PhD at a time. However, in any cases he/she will not allow to take more than 2 (two) PhD students at a time.

2.6.2.1.12 Any change of supervisor/co-supervisor shall have to be recommended by the CASR through BPGS. In such case, written consent of both present and proposed supervisor/co-supervisor has to be produced.

2.6.2.2 Charter of Duties of a Supervisor

The supervisor is expected to do the following:

2.6.2.2.1 Supervise the research work of the M. Sc. Engg./M.Engg. researcher.

2.6.2.2.2 Supervise the research for the duration of researcher's candidacy, which may include a period of extension to the researcher's submission deadline and may also include supervision during a period of resubmission.

2.6.2.2.3 Ensure face-to-face meeting with the Researcher's at least once in a month.

2.6.2.2.4 Ensure communication with Researcher at least once in a week by any means (i.e., telephone, email etc.)

2.6.2.2.5 Submit Research Progress Report to the Head of the respective department covering duration of three calendar months as specified in the Academic Calendar.

2.6.2.2.6 Examine the thesis as a member of Board of Examiners.

2.6.2.2.7 Attend the oral examination of the researcher for defense.

2.6.2.2.8 Maintain a comprehensive file of relevant documents, emails, correspondence etc. relating to supervision of the candidate.

2.6.2.2.9 If under any emergency circumstance such as going abroad for higher studies etc. he/she must inform the Dean/Head of the department at least one month prior to the discontinuation.

2.6.3 Academic Requirements and Regulations

2.6.3.1 The minimum duration of the M.Sc.Engg./M.Engg. program shall be three semesters. A student for the Master's degree program must complete all the requirements for the degree within five academic years from the date of the first admission in the respective programme.

2.6.3.2 Academic progress shall be measured in terms of Credit hours earned by a student. One Credit hour subject shall normally require 14 hours of lecture for one semester (14 weeks); while

one Credit hour for thesis/project work should normally require 42 hours of research work for one semester. The number of Credit hours for each subject shall be as specified in the syllabus of the respective department.

2.6.3.3 A student must complete a minimum of **36 credit hours** of which **18 credit hours** shall be assigned for a thesis for M.Sc.Engg. and **6 credit hours** as project work for M.Engg. Students can register thesis/project after completion of at least 12 credit hours theory courses.

2.6.3.3.1 Students are allowed to take more credit courses than minimum requirement for the calculation of GPA. The extra course should help the student to increase his/her CGPA than minimum requirement, and also in case Supervisor wants him/her to take addition courses related to his/her thesis work. However, the students need to take written permission for the extra courses from Supervisor and Head of the concern department. This has to be reported to the Controller of Examination of BUP through Controller of Examination of MIST.

2.6.3.3.2 The best grades among all the completed courses will be considered for CGPA calculation.

2.6.3.4 There shall be two categories of students, namely, full-time students and part-time students.

2.6.3.4.1 A student may enroll as a part-time student. Students, serving in different organizations, may also be admitted as part time students with the written consent of the employer. A part time student may be assigned a maximum of 9 credit hours of course including thesis work in any semester.

2.6.3.4.2 Full-time students must register for a minimum of 12 credit hours and a maximum of 15 credit hours per semester. A full-time student shall not be allowed to be in the employment of any organization (even as a part-time employee). However, they may be employed as Teaching/Research Assistant at MIST. If a full time student becomes an employee (full time or part time) of any other organization in the middle of a semester, he/she may, with the approval of the Head of the Department and his/her Employer, be allowed to continue as a full time student for that semester only.

2.6.3.4.3 A student may be allowed to switch from part-time to full-time or vice versa on the recommendation of the respective BPGS before the commencement of a semester.

2.6.3.5 The subjects of study in the different Departments/Institutes shall be as recommended by the respective BPGS and the Faculty and approved by CASR. The BPGS may review the curriculum from time to time and recommend any changes as may be considered necessary. At least 60% of the theory courses have to be completed from their major field of study.

A student on the recommendation of the BPGS and as approved by the CASR may be allowed to transfer a maximum of 9.0 credits of the courses (relevant to the field of study) completed by the student at a recognized institution provided that the courses were not taken earlier than five calendar years from the date of his/her first enrolment in the respective programme at MIST and that the student obtained a minimum GPA of 3.0 out of 4.0 or its equivalent in such courses and that the courses are equivalent to the approved courses of MIST.

2.6.4 Grading system

2.6.4.1 Final grades for courses shall be recorded as follows:

Grade	Merit description	Grade points
A (Plus)	Excellent	4.00
A	Very good	3.50
B (Plus)	Good	3.00
B	Average	2.6.30
C	Pass	2.00
F	Fail	0.00
S	Satisfactory	--
U	Unsatisfactory	--
W	Withdrawn	--
X	In Progress (for thesis)	--
I	Incomplete/Discontinued (for thesis)	--

Note: For already enrolled students the previously approved grading system will be followed till his/her completion of the degree.

2.6.4.2 Courses in which the student gets F grades shall not be counted towards credit hour requirements and for the calculation of Grade Point Average (GPA).

2.6.4.2.1 The C grades, up to a maximum of two courses, may be ignored for calculation of GPA at the written request of the student to the Head of the Department on the recommendation of the supervisor / program coordinator, provided that the student has fulfilled the total course credit hour requirement in the remaining subjects with a minimum CGPA of 3.00 (for M.Sc. Engg.) and 2.75 (for M.Engg.).

2.6.4.2.2 When a course is repeated for improvement, better grade shall be counted for calculation of GPA.

2.6.4.2.3 Performance in all the subjects excluding all the F grades shall be reflected in the transcript.

2.6.4.3 Grade "I" is given only when a student is unable to sit for the examination of a course at the end of the semester because of circumstances beyond his/her control. He/She must apply to the Head of the Department within one month after the examination to get an "I" grade in that course. It must be completed as soon as possible whenever the course is offered, otherwise, the "I" becomes an "F" grade. He/She may, however, be allowed to register without further payment of tuition fees for that course. If the course is not offered within next one year, the student can complete the course requirement by taking similar alternative course which should be approved by the BPGS.

2.6.4.4 Satisfactory or Unsatisfactory used only as final grades for thesis/project and non-credit courses. An "X" grade shall be recorded for thesis in progress. If, however, thesis is discontinued an "I" grade shall be recorded.

2.6.4.5 Students may enroll for non-credit course(s) termed as audit/research course(s) on recommendation of his/her thesis / project Supervisor and Head of the Department. However, his grades in audit/research course(s) will not be counted for calculating his CGPA.

2.6.4.6 A student shall withdraw officially from a course within two working weeks of the commencement of the semester or else his grade in that course shall be recorded as F unless

he/she is eligible to get a grade of "I". A student may be permitted to withdraw and change his/her course within the specified period with the approval of his/her Adviser, Head of the Department and the respective teacher(s) concerned. (In that case his / her grade in the courses registered shall be recorded as 'W' in his Academic Record but shall not be reflected in the transcript.)

2.6.4.7 Numerical markings may be made in answer scripts, tests etc., but all final grading to be reported to the Controller of Examinations (BUP) shall be in the letter grade system as detailed below:

90% and above	:	A (Plus)
80% to below 90%	:	A
70% to below 80%	:	B (Plus)
60% to below 70%	:	B
50% to below 60%	:	C
Below 50%	:	F

2.6.5 Research Proposal

All students must submit a research proposal following the format given in Annexure-3 (for M.Sc. Engg.) or Annexure-5 (for M.Engg.) to the BPGS of the respective department which shall examine the proposal and recommend it for the approval of the CASR. In special circumstances the BPGS may recommend to CASR for approval of any subsequent changes in the research proposal.

2.6.6 Conduct of Examination

2.6.6.1 In addition to tests, assignments and/ or examinations during the semester as may be given by the teacher(s) concerned, there shall be a written examination and / or other tests for each of the subjects offered in a semester at the end of that semester, the dates of which shall be announced by the Exam Section, MIST as advised by Dean at least two weeks before the commencement of the examination. The final grade in a subject shall be based on the performance in all tests, assignments and examinations.

2.6.6.2 The Exam Section and BUP shall keep up to date record of all the grades obtained by a student in individual Academic Record Card. Grades shall be announced by the Controller of Examinations at the end of each semester. In addition, each student is entitled to one official

transcript of the University record at the completion of his academic programme from the office of the Controller of Examinations on production of statement of clearance from all departments' offices.

2.6.6.3 The Head /BPGS of a department shall recommend the names of the paper setters and examiners for the semester examinations at least four weeks before the date of commencement of the examination to the Controller of Exam of MIST for approval.

2.6.7 Qualifying Requirements

The following are the qualifying requirements for the degree of M.Sc. Engg./M. Engg:

2.6.7.1 To qualify for the degree a student must earn a minimum grade point of 3.00 for M.Sc. Engg and 2.75 for M.Engg based on the weighted average of grade points (GP) in his/her course work.

2.6.7.2 Two courses may be repeated for improvement with the prior approval of the Head of the Department on the recommendation of the Supervisor/Program Coordinator. Such approval shall be reported to the BPGS.

2.6.7.3 A student obtaining "F" grade in a course may be allowed to repeat the course with the prior approval of Head of the Department on the recommendation of the Supervisor / Advisor. Such approval shall be reported to the BPGS.

2.6.7.4 A student is allowed to switch from M.Sc. Engg. to M.Engg. if his/her CGPA falls below the minimum requirement of the M.Sc. Engg. degree. This has to be approved by the respective BPGS on the written request from the student.

2.6.7.5 A student shall not be allowed to continue the programme if he/she obtains a total of three "F" grades in one or more than one subjects, during the whole course of his/her studies.

2.6.7.6 If at the end of the second or any subsequent semester (for full time students) and third or any subsequent semester (for part time students), the cumulative GPA falls below 3.00 for a M.Sc. Engg. student and 2.75 for a M.Engg. student he/she shall not be allowed to continue in the programme.

2.6.8 Thesis

2.6.8.1 A M.Sc. Engg. student finally shall submit a thesis on his/her research work fulfilling the other requirements mentioning in this Ordinance.

2.6.8.2 Research work for the thesis shall be carried out under the supervision of a Supervisor and a Co-supervisor (if required).

2.6.8.3 If any change is necessary of the approved thesis (title, content, cost, Supervisor, Co-supervisor etc.), it shall be approved by the CASR on recommendation of the relevant BPGS.

2.6.8.4 The research work must be carried out in MIST or at a place(s) recommended by the BPGS. The work schedule and financial involvement should be mentioned in the research proposal for carrying out the research work.

2.6.8.5 At the end of the student's research work, the student shall submit a thesis which must be an original contribution to engineering/sciences and worthy of publication.

2.6.8.6 The thesis submitted for the fulfillment of the degree of M.Sc. Engg. shall be written in English. The student must follow the Thesis writing guideline attached to this ordinance.

2.6.8.7 The student shall certify that the research work was done by him/her and that this work has not been submitted elsewhere for the award of any other diploma or degree (except for publication).

2.6.9 Examination of Thesis

2.6.9.1 Examination Board

2.6.9.1.1 An Examination Board for every student for thesis and oral examination shall be approved by the CASR through BPGS on recommendation of the thesis Supervisor in consultation with the Head of the Department. The Board shall consist of at least four members including the Supervisor as the Chairman and the Head of the Department as an Ex-officio and following the format as given in Annexure-4. The Board shall also include one or more external examiner(s).

The Examination Board shall be constituted as follows:		
(i)	Supervisor	Chairman
(ii)	Co-supervisor (if any)	Member
(iii)	Head of the Department (Ex-officio)	Member
(iv)	One or more members from within the Department/Institute	Member
(v)	One or more external member from any other reputed National/International Institutes/Universities/Organizations	Member (External)

If any member holds two portfolios (i.e., Head of a Department becomes Supervisor), then one additional internal member can be included in the board. In any case if Head of a department is unable to act as an Ex-officio, then the Faculty Dean will act as an Ex-officio. In case of non-availability of an internal member in related field, one additional external member can be included in the board from any reputed public university.

2.6.9.1.2 All the members of the Thesis Examination Board should be PhD holder and should have expertise on the same field of study of the student. They should have experience of supervision and/or thesis examination of Masters Candidates.

2.6.9.1.3 If the external examiner is appointed from outside the country a copy of the thesis should be sent for his/her evaluation and his/her written opinions are to be placed before the Examination Board.

2.6.9.1.4 If any examiner is unable to accept the appointment or has to relinquish his/her appointment before the examination, Commandant, MIST shall appoint another examiner in his/her place, on suggestion from the Supervisor in consultation with the Head of the department. This appointment will be reported to the CASR.

2.6.9.2 Thesis Examination

2.6.9.2.1 Every student submitting a thesis in partial fulfillment of the requirements of a degree, shall be required to appear at an oral examination, on a date fixed by the Supervisor in

consultation with the Head of the Department and must satisfy the examiners that he/she is capable of intelligently applying the results of this research to the solution of problems, of undertaking independent work, and also afford evidence of satisfactory knowledge related to the theory and technique used in his/her research work.

2.6.9.2.2 Every student shall submit to the Head of the Department, through his/her Supervisor, required number of type written soft bound copies of his/her thesis in the approved format (as given in Annexure-7) on or before a date to be fixed by the Supervisor in consultation with the Head of the Department along with transcript of the course work and copy/copies of published article.

2.6.9.2.3 After necessary scrutiny, the Head will forward the thesis with other documents (transcripts, published articles) to the member of the Examination Board.

2.6.9.2.4 The M.Sc. Engg. Thesis shall be examined by all members of the Examination Board. After examination of the thesis, all members shall send their reports within 2 weeks after receiving the soft bound thesis in a sealed envelope to the Head of the concerned department and a copy to the Controller of Examination of MIST.

2.6.9.2.5 On the basis of positive opinions from majority of the examiners except Supervisor and Co-supervisor that satisfies the thesis is standard and justified for Oral Examination, the Ex-officio of the Thesis Examination Board in consultation with the Supervisor shall arrange an Oral Examination for the M.Sc. Engg. student to defend his/her Thesis.

2.6.9.2.6 If any external examiner is appointed from outside the country, he/she shall be invited for attending the Oral Examination. In case, he/she is unable to attend the oral examination, the oral examination shall be arranged in absence of him/her, provided he/she gives his/her consent to do so.

2.6.9.2.7 On the basis of the negative opinions from majority of the examiners except Supervisor and Co-supervisor that do not satisfy the thesis as standard, the Thesis Examination Board shall decide either to reject the thesis or may recommend to allow the student to resubmit the thesis after necessary revision and modification as suggested by the examiners within 6 (six) months from the date of supply of comments of examiner. In such case, further registration will not be necessary. The Ex-officio of the thesis Examination Board shall report their decision to the Controller of Examinations of this Institute.

2.6.9.2.8 In case equal numbers of examiners are in favour and against, the Ex-officio will propose and get approval from CASR for a third external examiner on the relevant field and take his opinion whether the student will be allowed for Oral examination or reject/resubmit the thesis. For unavoidable circumstances, Commandant may give approval of the third external examiner which has to be post facto approved in the next CASR meeting.

2.6.9.2.9 In case, the student is unable to satisfy the Oral examination even the thesis is adjudged adequate, the Thesis Examination Board may recommend that the M.Sc. Engg. student may be

permitted to appear at another oral examination on a date to be fixed by the Supervisor in consultation with the Head of the Department.

2.6.9.2.10 After successful Oral examination and necessary corrections recommended by the thesis Examination Board, every candidate will submit necessary copies of hard bound thesis following the template to the concern persons/department.

2.6.9.2.11 The Thesis Examination Board will forward the results of the M.Sc. Engg. student to Controller of Examinations of MIST. The results will be send to the Controller of Examination of BUP for approval and then the degree will be awarded.

2.6.10 Project

2.6.10.1 A M.Engg student finally shall submit a project report on his/her research work fulfilling the other requirements mentioning in this Ordinance.

2.6.10.2 Research work for the report shall be carried out under the supervision of a Supervisor.

2.6.10.3 If any change is necessary of the approved project (title, content, cost, Supervisor etc.), it shall be approved by the CASR on recommendation of the relevant BPGS.

2.6.10.4 The research work must be carried out in MIST or at a place(s) recommended by the BPGS. The work schedule and financial involvement should be mentioned in the research proposal for carrying out research work.

2.6.10.5 At the end of the student's research work, the student shall submit a project report which must be an original contribution to engineering/sciences.

2.6.10.6 The report submitted for the fulfillment of the degree of M.Engg. shall be written in English. The student must follow the writing guideline attached to this ordinance.

2.6.10.7 The student shall certify that the research work was done by him/her and that this work has not been submitted elsewhere for the award of any other diploma or degree (except for publication).

2.6.11 Examination Board-Project

2.6.11.1 An Examination Board for every student for his/her project and oral examination shall be approved by the CASR on recommendation of the thesis Supervisor in consultation with the Head of the Department. The Board shall consist of at least three members including the Supervisor as the Chairman following the format as given in Annexure-6. The Supervisor shall act as the Chairman and propose the other board members.

The Examination Board shall be constituted as follows:

(i)	Supervisor	Chairman
(ii)	One or two member from within the Department/Institute	Member
(iii)	One external member from any other reputed National Institutes/Universities/Organizations	Member (External)

If any member holds two portfolios (i.e., Head of a Department becomes Supervisor), then one additional internal member can be included in the board. In case of non-availability of an internal

member in related field, one additional external member can be included in the board from any reputed public university.

2.6.11.2 All the members of the Project Examination Board should be at least Masters degree holder and have expertise on the same field of study of the student. They should have experience of supervision and/or thesis examination of Masters Students.

2.6.11.3 If any examiner is unable to accept the appointment or has to relinquish his/her appointment before the examination the BPGS shall appoint another examiner in his/her place on the recommendation of his/her supervisor. This modification will be reported to the CASR.

2.6.11.4 Every student shall submit to the Head of the Department, through his/her Supervisor, required number of type written soft bound copies of his/her project report in the approved format (as given in Annexure-7) on or before a date to be fixed by the Supervisor concerned in consultation with the Head of the Department along with transcript of the course work and copy/copies of published article (if any).

2.6.11.5 After necessary scrutiny, the Head will forward the project report with other documents to the members of the Examination Board at least 2 weeks before the oral examination. The report shall be examined by all members of the Examination Board.

2.6.11.6 Every student submitting a project report in partial fulfillment of the requirements of a degree, must be required to appear at an oral examination, on a date or dates fixed by the Supervisor concerned in consultation with the Head of the Department and must satisfy the examiners that he/she has gained satisfactory knowledge related to the project work.

2.6.11.7 In case a student fails to satisfy the Examination Board by project report and /or oral examination, the student shall be given one more chance to resubmit the project report and/or appear in another oral examination as recommended by the Board.

2.6.11.8 After successful Oral examination and necessary corrections recommended by the Project Examination Board, every candidate will submit necessary copies of hard bound project report following the template given in Annexure-7.

2.6.11.9 The Project Examination Board will forward the results of the M.Engg student to Controller of Examinations of MIST through Graduate Course Coordinator. The results will be send to the Controller of Examination of BUP for approval and then degree will be awarded.

2.6.12 Striking off and Removal of Names

2.6.12.1 The name of the student shall be struck off and / or removed from the rolls of the

Institute on the following grounds:

(i) Non-payment of dues within prescribed period. Post graduate students residing in the halls of residence shall be subject to the same conditions as allowed in the Policies Relating to the Hall of Residence and Discipline.

(ii) Failing to make satisfactory progress in his/her programme as reported by the supervisor through the BPGS and approved by CASR.

(iii) Forced to discontinue his/her studies under disciplinary rules.

(iv) Withdrawn officially from the Master Degree Programme

2.6.13 Academic fees

Items of Academic fees shall be as per MIST policy, and these fees shall be reviewed and recommended from time to time by the Governing Body of MIST

ANNEXURE – 1

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY, DHAKA
OFFICE OF THE MEMBER SECRETARY OF THE COMMITTEE FOR ADVANCED STUDIES AND RESEARCH

Application for the **Approval of Supervisor and/or Co-Supervisor** for Ph.D./ M.Phil./ M.Sc.Engg./ M.Engg. Thesis/Project

(All the items/sub-items of the following list that are applicable to ones must be mentioned and filled in properly)

Date of Application:

1. **Name of the Student:** **Status:** Full Time/ Part Time
   Roll No: **Session:** Apr.20…./Oct.20.....
2. **Present Address:**
   Email: Tel No:
3. **Name of the Department:**
   Program (Ph.D./M.Phil./M.Sc.Engg./M.Engg.): Division (if any):
4. **Session of First Enrolment in the Program:**
5. **Name of the Supervisor:** Affiliation:

Email: Tel No:

6. **Name of the Co-Supervisor** (if any)**:** Affiliation:
7. **List of Courses so far Completed with Course No, Course Title, Credit Hour, Grade, Grade Point and CGPA:***(To be verified and signed by the Program Coordinator)*

Sl. No	Course No	Course Title	Credit	Grade	Grade Point	CGPA

Signature of the Program Coordinator
Date:

8. **Number of Postgraduate Students Working with the Supervisor at Present:**

Ph.D.: M.Phil./ M.Sc.Engg.: M.Engg.:

9. **BPGS Reference**: Date of BPGS Meeting:

Signature of the Student
Date:

Signature of the Supervisor
Date:

Signature of the Co-Supervisor
Date:

Signature of the Head of the Dept.
Date:

ANNEXURE – 2

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY, DHAKA
OFFICE OF THE MEMBER SECRETARY OF THE COMMITTEE FOR ADVANCED STUDIES AND RESEARCH
Application for the **Approval of Doctoral Committee**

(All the items/sub-items of the following list that are applicable to ones must be mentioned and filled in properly)

Date of Application:

1. **Name of the Student:** **Status**: Full Time / Part Time
   Roll No: Session: Apr. 20…. / Oct. 20….
2. **Present Address:**
   Email: Tel No:
3. **Name of the Department:**
   Program (Ph.D./M.Phil./M.Sc.Engg./M.Engg.): Division (if any):
4. **Session of First Enrolment in the PhD Program:**
5. **Appointment of Supervisor & Co-supervisor Approved by CASR** (if any)**:**

Meeting No: Date:

6. **Name of the Supervisor**: Affiliation:

Email: Tel No:

7. **Name of the Co-supervisor (if any):** Affiliation:
8. **Tentative Title of Thesis:**

9. BPGS Reference: Date of BPGS Meeting:

Signature of the Student:

Date:

To be filled in by the Head of the Department and Supervisor

10. Proposed Doctoral Committee:

(i)	**Name:** Designation: Affiliation:	(Supervisor)	**Chairman**
(ii)	**Name:** Designation: Affiliation:	(Co-Supervisor, if any)	**Member**
(iii)	**Name** (Head of the Dept.)**:** Designation: Affiliation:	(Ex-Officio)	**Member**
(iv)	**Name:** Designation: Affiliation:		**Member**
(v)	**Name:** Designation: Affiliation:		**Member**
(vi)	**Name:** Designation: Affiliation:		**Member**
(vii)	**Name:** Designation: Affiliation:		**Member**

Signature of the Supervisor
Date:

Signature of the Head
Date:

ANNEXURE – 3
MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY, DHAKA
OFFICE OF THE MEMBER SECRETARY OF THE COMMITTEE FOR ADVANCED STUDIES AND RESEARCH

Application for the **Approval of Ph.D. Thesis Proposal**

(All the items/sub-items of the following list that are applicable to ones must be mentioned and filled in properly)

Date of Application:

1. **Name of the Student:** **Status:** Full Time/ Part Time
   Roll No: **Session:** Apr. 20…. / Oct. 20….
2. **Present Address:**
   Email: Tel No:
3. **Name of the Department:**
   Program (Ph.D./M.Phil./M.Sc.Engg./M.Engg.): Division (if any):
4. **Session of First Enrolment in the Program:**
5. **Name of the Supervisor:**

Affiliation:

Email: Tel No:

6. **Name of the Co-Supervisor** (if any)**:** Affiliation:
7. **Thesis Title** (IN BLOCK LETTER)**:**

8. **Background and Present State of the Problem:** *(Not more than 150 words)*

Please mention only those activities which have been carried out in different places as reported in publications. Please support your information by citing the relevant references. Keep your description within 150 words.

9. **Objectives with Specific Aims and Possible Outcome:** *(Not more than 150 words)*

Please list the objectives and the possible outcomes using short sentences. If you are writing one or two paragraphs for describing the objectives and the outcomes please limit yourself within 150 words.

10. **Outline of Methodology/Experimental Design:** *(Not more than 200 words)*

Outline the approach and the sequence of activities in not more than 200 works to describe how the work will be carried out.

11. **References:**

Give only the references which you have indicated as number style (i.e., [1] or [1-3] etc.) in the item 8 (background and present state of the problem). While giving the references you must mention clearly the name of author(s), title of the paper/book/dissertation, name of the journal/proceeding/publisher/university, vol. no., year of publication etc. in chronological order.

12. List of Courses so far Completed with Course No, Course Title, Credit Hour, Grade, Grade Point and CGPA: *(To be verified and signed by the Program Coordinator)*

Sl. No.	Course No	Course Title	Credit	Grade	Grade Point	CGPA

Signature of the Program Coordinator:

Date:

13. Cost Estimate: (*Break-ups can be provided in separate sheets, if required*)

Sl. No.	Items	Cost (Tk.)
1	Cost of Material (breakup needed)	
2	Field Works / Cost of Experimental Setup (if applicable)	
3	Conveyance / Data Collection (with breakup)	
4	Typing, Drafting, Binding and Paper etc.	
Total Amount:		

14. Justification of having Co-Supervisor:

Co-Supervisor(s) are acceptable only if the supervisor can justify that the work requires considerable knowledge of a discipline other than his own field of work.

15. Appointment of Supervisor and Co-Supervisor Approved by CASR:

Meeting No: Date: Reference No:

16. Appointment of Doctoral Committee Approved by CASR:

Meeting No: Date: Reference No:

17. Doctoral Committee:

Sl. No.	Name of the Committee members with affiliation
1	Chairman (Supervisor):
2	Member (Co-supervisor, if any):
3	Member-1(Ex-officio): Head,
4	Member-2:
5	Member-3:
6	Member-4:

18. Result of the Candidacy Examination: (*Photocopy of result should be enclosed*)

Satisfactory/ Unsatisfactory Date:

19. BPGS Reference: Date of BPGS Meeting:

	Names and Signatures of the Members of the Doctoral Committee (5 to 7 Members)	
---------- Signature of the Supervisor: Date:	1	
---------- Signature of the Supervisor: Date:	2	
	3	
---------- Signature of the Supervisor: Date:	4	
	5	
---------- Signature of the Head of the Dept: Date:	6	
	7	

ANNEXURE – 4

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY, DHAKA
OFFICE OF THE MEMBER SECRETARY OF THE COMMITTEE FOR ADVANCED STUDIES AND RESEARCH

Application for the **Approval of Board of Examination for the Ph.D./M.Phil./M.Sc.Engg.**

Degree
(All the items/sub-items of the following list that are applicable to ones must be mentioned and filled in properly)

Date of Application:

1. **Name of the Student:** **Status**: Full Time/ Part Time
   Roll No: **Session**: Apr. 20…./ Oct. 20….
2. **Present Address:**
   Email: Tel No:
3. **Name of the Department:**
   Program (Ph.D./M.Phil./M.Sc.Engg.): Division (if any):
4. **Session of First Enrolment in the Program:**
5. **Title of the Thesis as Approved by CASR** (if any)**:**
6. **Thesis Proposal Approved by CASR** (if any)**:**
   Meeting No: Date: Reference No:
7. **Doctoral Committee Approved by CASR:**
   Meeting No: Date: Reference No:
8. **BPGS Reference:** Date of BPGS Meeting:
9. **List of Courses so far Completed with Course No, Course Title, Credit Hour, Grade, Grade Point and GPA:** *(To be verified and signed by the Program Coordinator)*

Sl. No.	Course No	Course Title	Credit	Grade	Grade Point	CGPA

Signature of the Program Coordinator:

Date:

10. **Name of the Thesis Supervisor:**

11. **Name of the Co-Supervisor** (if any)**:**

12. **Time Extension** (if any) **Approved by the CASR:**

Meeting No.: Date: Reference No:

Signature of the Student

Date:

To be Filled in by the Head of the Department/Supervisor

Date:

13. **Expected Date of Examination:**

14. **Suggested Board of Examiners:**

(i) Name:

Designation:

Affiliation:

(ii) Name:

Designation:

Affiliation:

(iii) Name (Head of the Dept.)**:** Designation:

Affiliation:

(iv) Name:

Designation:

Affiliation:

(v) Name:

Designation:

Affiliation:

Signature of the Supervisor:

(Supervisor) **Chairman**

(Co-Supervisor, if any) **Member**

(Ex-Officio) **Member**

Member (Internal)

Member (External)

Signature of the Head of the Dept.:

Date:

ANNEXURE – 5

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY, DHAKA
OFFICE OF THE MEMBER SECRETARY OFmTHE COMMITTEE FOR ADVANCED STUDIES AND RESEARCH

Application for the **Approval of M.Engg. Project Proposal**

(All the items/sub-items of the following list that are applicable to ones must be mentioned and filled in properly)

Date of Application:

1. **Name of the Student:** **Status:** Full Time/ Part Time

   Roll No: **Session:** Apr. 20…. / Oct. 20….

2. **Present Address:**

   Email: Tel No:

3. **Name of the Department:**

4. **Session of First Enrolment in the Program:**

5. **Name of the Supervisor:**

Affiliation:

Email: Tel No:

6. **Project Title:** (IN BLOCK LETTERS)

7. **Total Cost of the Project:** Tk. (In words)**:**

8. BPGS Reference: Date of BPGS Meeting:

9. **Project Proposal:** *(Not more than 200 words)*

Please describe briefly background, specific objective, methodology and possible outcome of the project in not more than 200 words.

Signature of the Student:
Date:

Signature of the Supervisor:

Date:

Signature of the Head of the Dept.:

Date:

ANNEXURE – 6

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY, DHAKA
OFFICE OF THE MEMBER SECRETARY OF THE COMMITTEE FORADVANCED STUDIES AND RESEARCH

Application for the **Approval of Board of Examination for the M.Engg. Degree**

(All the items/sub-items of the following list that are applicable to ones must be mentioned and filled in properly)

Date of Application:

1. **Name of the Student:** **Status:** Full Time/ Part Time
   Roll No: **Session**: Apr. 20…. / Oct. 20….
2. **Present Address:**
   Email: Tel No:

3. **Name of the Department**:

4. **Session of First Enrolment in the Program**:

5. **Name of the Supervisor**: Affiliation:

6. **Title of the Project**:

7. **Project Proposal Approved by CASR:**

   Meeting No: Date: Reference No:

8. **Approved Time Extension (if any) up to**:

   CASR Meeting No: Date: Reference No:

9. **BPGS Reference**: Date of BPGS Meeting:

10. **List of Courses so far Completed with Course No, Course Title, Credit Hour, Grade, Grade Point and CGPA:** *(To be verified and signed by the Program Coordinator)*

Sl. No	Course No	Course Title	Credit	Grade	Grade Point	CGPA

---------- ----------

Signature of the Program Coordinator: Signature of the Student:
Date: Date:

To be Filled in by the Head of the Department/Supervisor

11. Expected Date of Examination:

12. Suggested Board of Examiners:

(i)	**Name:** Designation: Affiliation:	(Supervisor)	**Chairman**
(ii)	**Name** (Head of the Dept.)**:** Designation: Affiliation:	(Ex-Officio)	**Member**
(iii)	**Name:** Designation: Affiliation:		**Member**
(iv)	**Name:** Designation: Affiliation:		**Member**

Signature of the Supervisor:
Date:

Signature of the Head of the Dept.:
Date:

ANNEXURE – 7 (Thesis Format)

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

General Guidelines on Format of Thesis Submitted for Examination or Final

Submission
1. General Information

A Master's thesis must make some contribution to knowledge and not be mere collation of existing material. A PhD thesis must make a significant contribution to the knowledge of the subject concerned or provide evidence of originality either by the discovery of new facts or by the exercising of independent critical ability.

Work which has been submitted for another degree, or for which a degree has already been conferred by this Institute or any other university, may not be submitted again as a thesis but you are not precluded from incorporating part of such work provided that, in the thesis, you clearly indicate the part of the work which has been so incorporated.

Furthermore, please note that any work carried out before your enrolment in the University cannot be used for submission in a thesis examination, unless you have obtained approval from your supervisor and the Faculty.

The thesis must be written in English unless otherwise specified. Before submission of the thesis, you should seek consent from copyright owners for the inclusion of any third party proprietary/confidential intellectual property in the thesis.

Politically and commercially-sensitive information; or proprietary/confidential information which is not critical to the thesis and for which consent is not granted, should be excluded from the thesis. If necessary, such information could be included as appendices instead.

Most thesis authors experience major difficulties with tense in their documents. Many theses become a muddled mixture of past, present and future tense. To alleviate this problem, a simple solution is to treat the thesis as a historical document which will be read many years from the date of publication. The following grammatical procedure can then be adopted:

All general discussions and all discussions of experiments, equipment, etc. are written in the past tense (e.g., "*The test-tubes were acquired from a standard batch that was available at the time of experimentation...*").

References to mathematical formulae are written in the present tense (e.g., "*Equation 7.2 highlights the relationship between...*").

References to objects (sections, tables, diagrams, etc.) in the thesis are in the present tense (e.g., "*Section 2.9 contains a discussion on...*").

References to future work are also written in the past tense (e.g., "*It was determined that future developments could lead to an increase in...*").

2. Thesis Title

The title has to be approved from the CASR after having recommendation from BPGS. If the thesis title differs significantly from the original approved title, the candidate must request for a change of title using the prescribed application form and take necessary approval from the CASR.

3. General Formatting

Page Size	Each copy of the thesis must be printed on A4 size (8.27" x 11.69") paper (offset paper with minimum weight should be 80 gm) with white background and black colour font for the text.
Print Quality	Clear, clean and sharp copies are required. In the case of photocopies, no fading, extraneous marks or gray background should appear.
Margins	The top, bottom and right margins should be 25 mm from the edge of the paper and left margin should be 35 mm from the edge of the paper. A right justified margin is acceptable which must be consistent throughout the thesis.
Font	The font size for the main text should be 11 to 12 points. The same font type and size should be used for the entire thesis (with possible exception for figures and appendices). Do not choose a font that is difficult to read. The following fonts are acceptable: Times Roman and Helvetica.
Line Spacing	The text should be double-spaced throughout with the following exceptions: Captions for Figures/Tables: should be single-spaced List of Figures/Tables: should be single-spaced and double-spaced between entries Footnotes: should be single-spaced
Page Numbering	All pages except the title page must be paginated. The page numbers must appear at the bottom centre of the page. The position of the page numbers should not change even on pages with landscape mode illustrations. All material preceding the thesis proper (introductory sections starting from acknowledgements to summary) may have a separate sequence of numbering, preferably in roman numerals beginning with i. Plates, maps, plans, diagrams, tables, etc., should also be given a separate sequence of numbering. The main body of the thesis should be numbered in arabic numerals from 1 onwards. The numbering must be consecutive throughout the thesis and should include all maps, diagrams, photographs, etc. Published material submitted with the thesis whether bound in with the thesis or not, should not be included in the pagination but must maintain the same margins, font type and size. For a thesis which consists of more than one volume, one numbering sequence should be used, for example, if volume I ends at p.200, volume II should begin with p.201.
Footnotes	Footnotes should appear at the bottom of each page for easy reference and not at the end of the chapter.

Printing	The thesis should be printed in single sided format.

4. Sequence of Content

The content of the thesis should be in the following order:
Title page

A blank page
Approval page Declaration page Summary

Acknowledgements Table of Contents List of Tables
List of Figures

List of Illustrations List of Symbols

Main body of thesis

Bibliography or references Appendices

A blank page

5. Title Page

The title page should contain the following information in BLOCK LETTERS not exceeding 16 points:

Thesis title

Candidate's name (with qualification(s) in brackets)

The words: "**A THESIS SUBMITTED FOR THE DEGREE OF** <NAME OF DEGREE>"

Department: **DEPARTMENT OF** <NAME OF DEPARTMENT>

Name of Institute/University: **MILITARY INSTITUTE OF SCIENCE AND**

TECHNOLOGY

Year of first submission of thesis: If the thesis is resubmitted in a subsequent year, the year of submission to be indicated on the title page should remain as year of first submission.

Sample of the Title Page:

A MODELING STUDY OF WASTEWATER

TREATMENT PLANT

Rafi Rahman

(*BSc Engg., MIST*)

A THESIS SUBMITTED

FOR THE DEGREE OF MASTER OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

2019

6. Declaration Page

The words on this page should be of a font size of 12 points. The following should be stated:

"*Declaration*

I hereby declare that this thesis is my original work and it has been written by me in its entirety. I have duly acknowledged all the sources of information which have been used in the thesis. This thesis has also not been submitted for any degree in any university previously."

Candidate should sign at the bottom of the page with the candidate's name and the date indicated.

Sample of the Declaration Page:

DECLARATION

I hereby declare that this thesis is my Original work and it has been written by me in its entirety. I have duly acknowledged all the sources of information which have been used in the thesis.

This thesis has also not been submitted for any degree in any university previously.

_____

Rafi Rahman

1 April 2019

7. Summary

The thesis must contain a summary of not more than 500 words written in the English Language in each copy of the thesis. The summary should be a miniature version of the thesis and should contain summary of the results, conclusions and main arguments presented in the thesis.

8. Photographs, Illustrations and Other Attachments

Photographic and other illustrations should be securely mounted using double-faced tape. Photograph album pockets or slits in the page are not adequate. In no circumstances should 'cellophane tape' or a similar material be used for any purpose in a copy of the thesis. All copies of the thesis should contain original photographs.

Subsidiary papers and other loose material should be bound in wherever possible. If this is not possible, an adequately guarded pocket for each material should be provided at the end of the thesis. Any such loose material (and corrigenda sheets, if not bound in) should bear the candidate's name, initials and degree.

9. Approval Page

The approval page has to be included in the hard bound final copy of the thesis.

Sample of the Approval Page:

The thesis titled …… …… Submitted by ……. Roll No: ……. Session: …… has been accepted as satisfactory in partial fulfillment of the requirement for the degree of …….. on……

Board of Examiners

1.	(Signature) Name of the supervisor Designation & Address	Chairman
2.	(Signature) Name of the supervisor Designation & Address	Member
3.	(Signature) Name of the supervisor Designation & Address	**Member**
4.	(Signature) Name of the supervisor Designation & Address	**Member (Ex-officio)**
5.	(Signature) Name of the supervisor Designation & Address	**Member (External)**

10. Main Bodies

1. CHAPTER TITLES SHOULD BE CENTERED BOLD 14 POINT Text in the chapter titles should be in upper case.

1.1 Secondary Headings Should be Flash Left 12 Point Bold

The first letter in each word of the secondary heading should be capitalized.

1.1.1 Third level headings should be flush left 12 point bold

Only the first letter of the first word of the third level heading should be capitalized
In the case of the paragraph starting left justified, there should be a spacing between the paragraphs. Otherwise, the paragraphs may be indented by a consistent amount.
The font, point size, positioning, numbering and referencing of equation:

The typeface for equations will be 12 point Times New Roman and are to be numbered sequentially by chapters (right justified). Reference for equation numbers in the text should be enclosed in parenthesis, such as (5.2).

The layout and numbering of figures and tables and their captions:

Figures should be centered between the left and right margin with their captions centered below the figure in point size 12 Times New Roman single spaced. Figures should be consecutively numbered per chapter. The word Figure may be abbreviated as "Fig". Tables should be centered between the left and right margin with their captions

(12 point Times New Roman) centered above the table. Tables should be consecutively numbered per chapter. Main heading and number of Figures and Tables should be bold.

Part B gives an overview of different chapters of a thesis.

11. References

A numbered list of references must be provided at the end of the thesis, before any appendices. The list should be numbered either in the order of citation in the text, or in alphabetical order, and there should be only one reference per reference number. Each reference number should be enclosed in square brackets. Samples are shown below:

Books:

[1] Brognakke, C. (1984), "Flame Propagation and Heat Transfer Effets in Spark Ignition Engines", In J. C. Hillard and G. S. Springer (eds.), Fuel Economy in Road Vehicles Powered by Spark Ignition Engines, chap 5, pp 183-224, Pienum Press, New York.

[2] Farrelly, D. (1966), "*The book of bamboo*", Thames and Hudson Ltd., London.

Journals/Periodicals:

[3] Benson, R. S., Garg, R. D. and Woolatt, D. (1964), "A Numerical Solution of Unsteady Flow Problems", *Journal of Mechanical Engineering*, vol. 6, pp. 117-144.

Articles from published conference proceedings:

[4] Nichols, M. A., Siegel, H. J. and Nation, W. G. (1990), "Minimizing memory requirements for partitionable SIMD/SPMD machines", *Proceedings of the International conference on Parallel Processing*, pp. 84-91.

Papers presented at conferences (unpublished):

[5] Ebehard, D. and Voges, E. (1984), "Digital single sideband detection for interferometric sensors", *presented at 2nd International conference on Optical Fiber Sensors*, Stuttgart, Germany.

Reports:

[6] GOB (1993), National housing policy 1993. Government of Bangladesh, Ministry of Housing and Public Works, Dhaka, Bangladesh.

Thesis:

[7] Rahman, M. A. (1998), "The structure of Turbulent Mixing Layers", *M. Sc. Engg. Thesis*, Department of Mechanical Engineering, BUET, Bangladesh, pp. 198.

12. Appendices

Appendices should contain supplementary material that the author considers necessary to the interpretation of the text itself. Long tables, essential raw data, detailed reports or computer are generally more appropriately included in an appendix. Appendices should not be longer that the body of the thesis and normally would be considerably shorter. If there is more than one appendix, the appendices should be numbered in sequence using Arabic numerals. Appendices should be numbered as A-1, A-2, … B-1, B-2… etc. for respective appendix.

13. Thesis Cover and Spine

The front cover and spine of the thesis should contain only the following information in BLOCK LETTERS. The font size on the cover should not exceed 16 points:

<table>
<tr>
<td>Thesis Cover:

• Thesis Title
• Candidate's Name
• Name of Institute
• Year of first submission</td>
<td>Thesis Spine:

Thesis Title (or an abbreviated title)

Candidate's Name
Year of first submission</td>
</tr>
<tr>
<td>Sample of Thesis Cover:

A MODELING STUDY OF WASTEWATER TREATMENT PLANT

RAFI RAHMAN

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

2019</td>
<td>Sample of Thesis Spine

A MODELLING STUDY OF RAFI RAHMAN 2019 WASTEWATER TREATMENT PLANT</td>
</tr>
</table>

14. Type of Cover/Binding

For submission of your thesis for examination/re-examination, the thesis should be=bound with soft cover (light blue with black lettering not exceeding 16 points) using saddle-stitch or perfect binding (spiral or ring-back binding is not acceptable).

.

PhD:	Black
M.Sc./M.Phil:	Dark Blue
M..Engg.:	Blue

Format of the thesis

Chapter 1 - Introduction (Thesis Body)	This is the most crucial chapter in the thesis and the one which requires the most careful consideration. The reader must be introduced, in a step by step fashion, to the purpose of the project, concepts and ideas related to the project and the structure of the following sections of the thesis. This section should endeavour to treat technical issues in a ***qualitative*** manner so that the reader can clearly understand the task at hand, without reference to other texts or periodicals. Formal page numbering for the body of the thesis begins in this section. Pages should preferably be numbered in a simple sequential order and should be chapter independent (ie: page numbers such as 1.2, 2.7 are not appropriate).
Chapters 2..N (Thesis Body)	This is the portion of the thesis in which literature surveys are discussed, research and development techniques are explained, theories, models and systems formulated and results evaluated. In general, the body of the thesis should be free from long, complex calculations, routine mathematical proofs, program code or large volumes of raw data. Page numbering continues on from the introductory chapter.
Chapter N+1 Conclusions and Recommendations for Further Work	This should draw together the main findings of the research program, together with findings of literature surveys carried out at the beginning and the end of the research program. Recommendations should also be made for future research in related areas. Page numbering should be a continuation from the previous section.
References	A listing of all references from which data has been abstracted for the purposes of the thesis. Preferably, the references should be listed in the order in which they are referred to in the body of the thesis. Page numbering is a continuation of previous sections.
Appendices	Appendices are used to store important calculations, proofs, tables or code which would interrupt the flow of qualitative descriptions in the body of the thesis. Each appendix has its own page numbering scheme. For example, Appendix A would have numbers A-1, A-2, etc. Appendix X would have numbers X-1, X-2, etc.
Index	This is generally an optional section in which common words or phrases, occurring in the body of the thesis are referenced to

	page numbers. Modern word-processors make the task of compiling an index considerably easier and hence authors may wish to include them. Page numbering can be a continuation of the Appendix Format.

Thesis Complexity by Chapter

Complexity	***Chapter***	***Function***
Lay-reader		Abstract
Lay-reader	1	Introduction
	2	Literature Review
Expert	3	Methodology and Implementation
	4	Experimental Procedures for Methodology Assessment
	5	Experimental Results and Observations
	6	Broad Context Discussion of Results and Relevance
Lay-reader	7	Conclusions and Recommendations for Further Work
-	-	References
-	-	Appendices

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY, DHAKA

OFFICE OF THE MEMBER SECRETARY OF

THE COMMITTEE FOR ADVANCED STUDIES AND RESEARCH
Progress Report of a Postgraduate Student for Ph.D./M.Phil./M.Sc.Engg./M.Engg. Degree

(All the items/sub-items of the following list that are applicable to ones must be mentioned and filled in properly)

Part I: To be Completed by the Student:

1. **Name of the Student:** **Status:** Full Tim / Part Time
   Roll No: Session: Apr. 20…. / Oct. 20….
2. **Present Address:**
   Email: Tel No:
3. **Name of the Department:**
   Program (Ph.D./M.Phil./M.Sc.Engg./M.Engg.): Division (if any):
4. **Session of First Enrolment in the Program:**
5. **Name of Supervisor:**
6. **Title of the Thesis** (if approved by CASR)**:**
7. **Expected Date of Completion of Degree**:
8. **List of Courses so far Completed with Course No, Course Title, Credit Hour, Grade, Grade Point and GPA:** *(To be verified and signed by the Program Coordinator)*

Sl. No.	Course No	Course Title	Credit	Grade	Grade Point	GPA

Signature of the Program Coordinator

Date:

9. **Research Activities and Findings** *(within 200 words)***:**

10. **Publications** ***(****List complete citations for all papers published and manuscripts in press or in preparation)***:**

<u>Part II: To be Completed by the Supervisor:</u>

11. **Comments by the Supervisor** *(Please provide a brief evaluation of the student's performance)***:**

12. Rating of Student's Performance by the Supervisor: (circle one)

Progress is excellent *Progress is satisfactory* *Progress is unsatisfactory*

---------- Signature of the Supervisor
Date:

---------- Signature of the Head of the Dept.
Date:

2.8. Teaching Strategy

Research paper review, Literature review, Case study of ethical issues in different research lab, effective dada management procedure Lecture, assignments presentation etc.

2.9. Assessment Strategy

Assessment Method	**Percentage**
Research paper review, Literature review, Case study of ethical issues in different research lab, effective dada management procedure Lecture, assignments presentation etc.	**50%**
Final Exam	**50%**

Grading system followed in MIST is mentioned in section 2.6.4

CHAPTER 3

COURSE PROFILE FOR THE MASTERS DEGREE PROGRAMMES

3.1 Detailed Syllabus of Post Graduate Courses

The detailed syllabus of the courses listed in paragraph 2.5 is enumerated in this section by serial.

GENERAL COURSES

Course Title: Thesis

Course Code: AE 6000

Level: Post-graduation program

Credit Hour: 18 for M.Sc. Engineering and 45 for PhD degree

Contact Hour: As required and specified by the supervisor and concerned committee/board.

Rationale: Compulsory course for M.Sc. Engineering and PhD degree based on advanced level of research in line with theoretical courses undertaken and fields under the guidance of assigned supervisor or doctoral committee to undertake innovation and development in science and technology for the well-being of mankind.

Course Content: As defined and specified by supervisor and concerned board.

Learning Outcomes (LO): On successful completion of this course unit, students should be able to:

1. Address a physical and scientific problem for in depth study;
2. Utilize mathematical models or experimental means developed for scientific researches;
3. Develop new mathematical models or experimental means for further researches;

Teaching-learning Strategy: Research papers review, Literature review, Laboratory works, Field visits, Industry evaluation etc.

Assessment Strategy: As convenient by supervisor and concerned board/committee.

Linkage of LO with Assessment Methods & their Weights:

As convenient by supervisor and concerned board/committee.

Mapping of Course LO and Program Outcomes (PO):

Will remain flexible for supervisor

Reference Books:

1. As advised by supervisor/co-supervisor/board.

Grading system: As per approved grading scale of MIST

Course Title: Project

Course Code: AE 6000

Level: Post-graduation program

Credit Hour: 6 for M. Engineering

Contact Hour: As required and specified by the supervisor and concerned committee/board.

Rationale: Compulsory course for M. Engineering on advanced level of research in line with theoretical courses undertaken and fields under the guidance of assigned supervisor to undertake innovation and development in science and technology for the well-being of mankind.

Course Content: As defined and specified by supervisor and concerned board.

Learning Outcomes (LO): On successful completion of this course unit, students should be able to:

1. Address a physical and scientific problem for in depth study;
2. Utilize mathematical models or experimental means developed for scientific researches;
3. Develop new mathematical models or experimental means for further researches;

Teaching-learning Strategy: Research papers review, Literature review, Laboratory works, Field visits, Industry evaluation etc.

Assessment Strategy: As convenient by supervisor and concerned board/committee.

Linkage of LO with Assessment Methods & their Weights:

As convenient by supervisor and concerned board/committee.

Mapping of Course LO and Program Outcomes (PO):

Will remain flexible for supervisor

Reference Books:

1. As advised by supervisor/co-supervisor/board.

Grading system: As per approved grading scale of MIST

Course Title: Seminar

Course Code: AE 6001

Level: Post-graduation program

Credit Hour: Non-Credit course. But the thesis/project course (AE 6000) will include the credit requirement of seminar (AE 6001) for M.Sc. Engineering, M. Engineering and PhD degree. The grading system of this course will be 'satisfactory' or 'unsatisfactory' as per MIST PG ordinance.

Contact Hour: As specified by the supervisor and BPGS of AE Dept.

Rationale: Compulsory course for for M.Sc. Engineering, M. Engineering and PhD degree based on ongoing advanced level of research in line with theoretical courses undertaken and fields under the guidance of assigned supervisor or BPGS of AE Dept.

Course Content: As defined and specified by supervisor and concerned board.

Learning Outcomes (LO): On successful completion of this course unit, students should be able to:

1. Present research works and review of research papers to the audience;
2. Interact with similar researchers;
3. Apply the research tools for further research.

Teaching-learning Strategy: Presentation and discussions.

Assessment Strategy: As convenient by supervisor and BPGS of AE Dept.

Linkage of LO with Assessment Methods & their Weights:

As decided by supervisor and concerned board/committee.

Mapping of Course LO and Program Outcomes (PO):

Will remain flexible for supervisor

Reference Books:

1. As advised by supervisor/co-supervisor/board.

Grading system: As per approved grading scale of MIST

Course Title: Research Methods for Engineers

Course Code: AE 6107

Level: Post-graduation program

Credit Hour: Non-Credit course. But the thesis/project course (AE 6000) will include the credit requirement of course AE 6107 for M.Sc. Engineering, M. Engineering and PhD degree. The grading system of this course will be 'satisfactory' or 'unsatisfactory' as per MIST PG ordinance.

Contact Hour: 3 (per week)

Rationale: Theoretical course to understand the formal procedure to conduct a research, ethics and guideline should be followed during research.

Course Content: As defined and specified by instructor.

Objective:

1. Retrieve and critically review scientific literature and information from peer-reviewed and grey literature sources.
2. Identify research problems and formulate relevant research questions within the field of disaster management and define and delimit study objectives.
3. Choose study designs and identify appropriate methods for data collection and analysis.
4. Discuss possible ethical considerations and limitations.
5. Critically interpret and discuss research findings in relation to existing evidence within the field.

Learning Outcomes (LO): On successful completion of this course unit, students should be able to:

1. Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline.
2. Application of systematic approaches to the conduct and management of engineering projects.
3. Ethical conduct and professional accountability.
4. Effective oral and written communication in professional and lay domains.
5. Professional use and management of information

Teaching-learning Strategy: Research papers review, Literature review, Case study of ethical issues in different research lab, effective data management procedure etc.

Assessment Strategy: As decided by instructor.

Linkage of LO with Assessment Methods & their Weights:

As decided by instructor.

Mapping of Course LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this course	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline.	✓											
2. Application of systematic approaches to the conduct and management of engineering projects.				✓								
3. Ethical conduct and professional accountability.								✓				
4. Effective oral and written communication in professional and lay domains.										✓		
5.Professional use and management of information										✓		

Reference Books:

1. As advised by supervisor/co-supervisor/board.

Course Title: Advanced Numerical Analysis

Course Code: AE 6102

Level: Post-graduation program

Credit Hour: 3

Contact Hour: 3 (per week)

Rationale: Theoretical course based on advanced level of mathematics to analyses of complex mechanical system using the numerical technique like finite difference method.

Course Content: Numerical computing and approximations; Numerical differentiation and Integration; Numerical solution of ordinary differential equations: Initial-value problems of linear and nonlinear system of equations, Shooting method, Boundary-value problems; Multi-segment method of solving unstable system of equations; Finite-difference technique of solving differential equations; Solution of linear Elliptic, Parabolic and Hyperbolic partial-differential equations: Engineering problems in Cartesian, cylindrical and spherical coordinate systems; finite-difference solution of non-linear partial-differential equations.

Objective:

1. Review and apply fundamental theory for mathematical modelling with partial differential equations;
2. Analyze finite difference and finite element approximations of systems of partial differential equations;
3. Review and describe application areas where different types of finite element and finite differences are used;
4. Choose, formulate and implement appropriate numerical methods for solving science and engineering problems that are formulated as partial differential equations;
5. Interpret, analyze and evaluate results from numerical computations;
6. Use common software to solve application problems formulated as more complicated partial differential equations, such as linear elasticity and transport problems.

Learning Outcomes (LO): On successful completion of this course unit, students should be able to:

1. Have sound mathematical background on numerical computing method
2. Convert a physical problem into a mathematical model.
3. Solve initial value and boundary value problem.
4. Solve systems expressed by linear elliptic, parabolic and hyperbolic or nonlinear partial differential equation.

Teaching-learning Strategy: Class lectures, Case studies, Research papers review, Problem solving using numerical method etc.

Assessment Strategy: Class tests, Assignments, Presentation and Final exam.

Mapping of Course LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this course	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Have sound mathematical background on numerical computing method	✓											
2. Convert a physical problem into a mathematical		✓										

model.												
3. Solve initial value and boundary value problem.					✓							
4. Solve systems expressed by linear elliptic, parabolic and hyperbolic or nonlinear partial differential equation.					✓							

Reference Books:

1. Advanced Engineering Mathematics – P. V. Oneil;
2. Applied Numerical Analysis – G. Wheatley;
3. Theoretical Numerical Analysis - Introduction to Advanced Techniques – Peter Linz.
4. Numerical Methods for Engineers – Steven C. Chapra, Raymond P. Canale

Course Title: Advanced Engineering Mathematics

Course Code: AE 6003

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to study first-order ordinary differential equations and second-order linear differential equations. Methods for solving differential equations are studied, including the use of Laplace transforms and power series solutions.

Course Contents:

Linear Algebra:- Review of Groups, Fields, and Matrices; Vector Spaces, Subspaces, Linearly dependent/independent, Basis, Dimensions; Isomorphism, Linear transformations and their matrix representations; Rank, Inverse of Matrices, System of Equations; Inner-product spaces, Cauchy-Schwarz Inequality; Orthogonality, Gram-Schmidt orthogonalisation process; Eigenvalue, Eigenvectors, Eigenspace; Cayley-Hamilton Theorem; Diagonalisation of matrices, Jordan

canonical form; Spectral representation of real symmetric, hermitian and normal matrices, positive definite and negative definite matrices.

Theory of Complex variables: -A review of the concept of limit, continuity, differentiability & analytic functions. Cauchy Riemann Equations, Line Integral in the complex plane, Cauchy Integral Theorem & Cauchy Integral Formula & its consequences, Power series & Taylor Series(in brief), Zeros & Singularity, Laurent' Series, Residues, Evaluation of Real Integrals.

Transform Calculus:- Concept of Transforms, Laplace Transform(LT) and its existence, Properties of Laplace Transform, Evaluation of LT and inverse LT, Evaluation of integral equations with kernels of convolution type and its Properties, Complex form of Fourier Integral, Introduction to Fourier Transform, Properties of general (complex) Fourier Transform, Concept and properties of Fourier Sine Transform and Fourier Cosine Transform,Evaluation of Fourier Transform, Solution of ordinary differential equation and one dim. Wave equation using Transform techniques,Solution of heat conduction equation and Laplace equation in 2 dim. Using Transform techniques.

Probability & Statistics : - A review of concepts of probability and random variables: Classical, relative frequency and axiomatic definitions of probability, addition rule, conditional probability, multiplication rule, Bayes' Theorem. Random Variables: Discrete and continuous random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, moment generating function. Standard Distributions: Uniform, Binomial, Geometric, Negative Binomial, Poisson, Exponential, Gamma, Normal. Sampling Distributions: Chi-Square, t and F distributions. Estimation: The method of moments and the method of maximum likelihood estimation, confidence intervals for the mean(s) and variance(s) of normal populations. Testing of Hypotheses: Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test, the most powerful test, tests of hypotheses on a single sample, two samples.

Objective:

1. Introduce students to ordinary differential equations and the methods for solving these equations
2. Use differential equations as models for real-world phenomena
3. Integrate the knowledge accumulated in the calculus sequence to solve applied problems
4. Introduce the fundamentals of Linear Algebra and Complex Analysis

5. Provide a rigorous introduction to upper-level mathematics which is necessary for students of engineering, physical sciences and mathematics

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Evaluate different mathematical tools and techniques used in electrical engineering.
2. Apply appropriate scientific and mathematical theories and laws to solve engineering problems.
3. Demonstrate theoretical knowledge to use in modern communication systems.
4. Apply statistical theories to solve engineering problems

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Evaluate different mathematical tools and techniques used in electrical engineering.	✓											
2. Apply appropriate scientific and mathematical theories and laws to solve engineering problems.						✓						
3. Demonstrate theoretical knowledge to use in modern communication systems.			✓									
4. Apply statistical theories to solve engineering problems.									✓			

Text and Ref Books:

1. Advanced Engineering Mathematics - Erwin Kreyszig
2. Advanced Engineering Mathematics - Dennis G Zill and Warren S Wright
3. Advance Engineering Mathematics - Zill D G
4. Advanced Engineering Mathematics - Jain R K

Course Title: Advanced Partial Differential Equations

Course Code: AE 6004

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to focus on the concepts and techniques for solving the partial differential equations (PDE) that permeate various scientific disciplines. The emphasis is on nonlinear PDE. Applications include problems from fluid dynamics, electrical and mechanical engineering, materials science, quantum mechanics, etc.

Course Contents:

Linear second order equations: Classification and reduction to canonical form of linear second order equations; solution of Cauchy problems for hyperbolic equations by reduction to canonical form; Well-posed problems for partial differential equations. **The wave equation**: energy method and uniqueness; solution by ”spherical means”; well posedness of initial value problem.**The heat equation**: Solutions using Gaussian kernel; uniqueness; maximum principle for heat equation; well posedness of initial value problem. **Laplace’s equation**: Basic properties of harmonic functions; maximum principle for boundary value problem; existence of solutions and well posedness of boundary value problems for Laplace’s equation; Green’s functions. **Nonlinear conservation laws** Discontinuous solutions of conservation laws; jump condition; model of a traffic flow; uniqueness and the entropy condition; Cole-Hopf transformation.

Objective:

1. Understand the classical methods to solve the Laplace, heat, and wave equations.
2. Understand the role of Sobolev norms and compact embeddings to solve PDEs and find spectral decompositions.
3. Learn the main methods available to solve nonlinear PDEs, through simple cases.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Demonstrate knowledge and understanding partial differential equations and how they relate to different modelling situations.
2. Solve linear ODEs and PDEs with the use of the Green's function method.
3. Show logical thinking in problem-solving.
4. Understand the concept of well-posedness.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Demonstrate knowledge and understanding partial differential equations and how they relate to different modelling situations.						✓						
2. Solve linear ODEs and PDEs with the use of the Green's function method.		✓										
3. Show logical thinking in problem-solving			✓									

4. Understand the concept of well-posedness.									✓			

Text and Ref Books:

1. Functional Analysis, Sobolev Spaces, and Partial Differential Equations - Haim Brezis.
2. An Introduction to Partial Differential Equations - Michael Renardy and Robert Rogers.
3. Nonlinear Differential Equations of Monotone Type in Banach Spaces - Biorel Barbu.
4. Applications of Functional Analysis and Operator Theory - Hutson and Pym.

Course Title: Human Factors Engineering and Ethics

Course Code: AE 6105

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to focus on knowledge and skills needed to design products and environments from a human perspective.

Course Contents:

Fundamental understanding of human factors related in the design of complex aviation and space systems. Design criteria from sensory, motor, and cognitive sources that include principles of displays, controls and ergonomics, manual control, the nature of human error, basic experimental design, and human-computer interaction in supervisory control settings; Ethics and professionalism, moral reasoning and ethics, moral framework, trust and reliability, code of ethics, case studies.

Objective:

1. The experimental design process in the context of designing a Human Factors study.
2. The importance of research ethics in the context of Human Factors studies.
3. The cognitive capability of humans in terms of situation awareness, decision making, and communication.
4. The system view of errors and accident analysis.
5. The role automation in modern sociotechnical systems.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Critically apply knowledge of the principles of Human Factors through the systematic investigation of complex issues to produce safe, efficient and cost-effective solutions in the engineering industry.
2. Apply Human Factors theories to practical case studies in which engineering-related scenarios are analysed.
3. Critically evaluate research findings and theories in the area of Human Factors in engineering.
4. Successfully complete an independently conducted research project in a subject area of Human Factors in engineering.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam. Graduate students are expected to complete a research-oriented project with a final written report and an oral presentation.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Critically apply knowledge of the principles of Human Factors through the systematic investigation of complex issues to produce safe, efficient and cost-effective solutions in the engineering industry.	✓											
2. Apply Human Factors theories to practical case studies in which engineering-related scenarios are analysed.		✓										
3. Critically evaluate research findings and theories in the area of Human Factors in engineering.			✓									
4. Successfully complete an independently conducted research project in a subject area of Human Factors in engineering.					✓							

Text and Ref Books:

1. Introduction to Human Factors Engineering - Wickens, Lee, Yili Liu, Gordon-Becker.
2. Field Guide to Understanding Human Error - Sidney Dekker.
3. Ethics in Engineering– Mike W. Martin

Course Title: Management for Technology

Course Code: AE 6106

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to focus on the use of technology to design and develop products and services that maximise customer satisfaction on the one hand, while maximising corporate productivity, profitability and competitiveness on the other.

Course Contents:

Project management: Scope definition, Planning and Scheduling, Critical path analysis; People management: Understanding you, Understanding other people, Working in teams, Dealing with conflicts; Marketing: Marketing technology, Selling technology, Market segmentation; Negotiation: Preparation for Negotiations, Negotiation process, Win-Win solutions; New product development: Commercializing technology, Market drivers, Time to market, Focusing technology, Concerns; Presentation skills: Understanding your audience, Focusing your message, Successful presentations, Getting your message across; Finance: Profit and loss accounts, Balance sheets, Cash flow forecasting, Project appraisal; Business game: Working in teams (companies), students will set up and run a technology company and make decisions on investment, R&D funding, operations, marketing and sales strategy.

Objective:

1. To analyse critical path.
2. To prepare for negotiations.
3. To prepare for successful presentations.
4. To prepare for working in teams (companies).

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Assess the range, scope, and complexity of the phenomena, issues, and problems related to technology management; Apply Human Factors theories to practical case studies in which engineering-related scenarios are analysed.
2. Discuss various problems where particular managerial decisions need to be taken such as technology acquisition and transfer.
3. Use a range of tools used in technology creation, search, assessment, selection, implementation, utilization, and strategy.
4. Describe the primary tasks and decisions that are required to turn a technological innovation into a sound business opportunity.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy:

As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Assess the range, scope, and complexity of the phenomena, issues, and problems related to technology management; Apply Human Factors theories to practical case studies in which engineering-related scenarios are analysed.	✓											
2. Discuss various problems where particular managerial decisions need to be taken such as technology acquisition and transfer.		✓										
3. Use a range of tools used in technology creation, search, assessment, selection, implementation, utilization, and strategy.			✓									
4. Describe the primary tasks and decisions					✓							

that are required to turn a technological innovation into a sound business opportunity.												

Text and Ref Books:

1. Strategic Management of Technological Innovation - Melissa Schilling
2. Strategic Management of Technology and Innovation- Robert A. Burgelman, Clayton M. Christensen, Steven C. Wheelwright.

Course Title: Advanced Weapon Engineering

Course Code: AE-6108

Level: Post-graduation program

Credit Hour: 3

Contact Hour: 3 (per week)

Rationale: Theoretical course on different design and inspection procedure of light weapons.

Course Content: Weapon classification, Light weapons/ small arms design (small arms theory and design, advanced trends in small arm, material selection and su treatment, ballistics, firing and operating mechanics, sighting system and safety), gun system design (gun design and barrel material and thermodynamics, breech system, recoil system and control system), Guided weapon system (Air frames, control, guidance, propulsion and warheads); Weapon inspection/ performance evaluation, Working principle of various types of RADAR used in weapon system.

Remark: Both the instructor and students for this course will be from military.

Objective: To learn about small arms design and details of guided weapon system.

Learning Outcomes (LO): On successful completion of this course unit, students should be able to:

1. Demonstrate knowledge weapon classification and current trend of small weapon used by different military of advanced world.
2. Design and modify small arms in terms of material, ballistics, control, safety etc.
3. Demonstrate knowledge on guided weapon system.
4. Evaluate the performance of different gun system.
5. Demonstrate knowledge on RADAR system used in weapon system

Teaching-learning Strategy: Class lectures, Case studies, Research papers review, Practical problem solution etc.

Assessment Strategy: Class tests, Assignments, Presentation and Final exam.

Linkage of LO with Assessment Methods & their Weights:

Mapping of Course LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this course	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Demonstrate knowledge weapon classification and current trend of small weapon used by different military of advanced world.	✓											
2. Design and modify small arms in terms of material, ballistics, control, safety etc.	✓		✓									
3. Demonstrate knowledge on guided weapon system.	✓											
4. Evaluate the performance of different gun system.				✓								
5. Demonstrate knowledge on RADAR system used in weapon system	✓											

Reference Books:

1. Small Arms: General Design - M. A. Toomey
2. Advances in Missile Guidance, Control, and Estimation – B.A. White
3. Guided Weapons - J. F. Rouse
4. Radar technology - Eli Brookner

Course Title: Advanced Automobile Engineering

Course Code: ME 6251

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to focus on the understanding of vehicle concepts and designs, including major systems, assemblies and components.

Course Contents:

Vehicle design characteristics including military vehicles; Vehicle material selection including military vehicles; Vehicle aerodynamics; Vehicle propulsion (Engine technology and performance analysis, transmission system); Vehicle dynamics (Improved automotive fuel system, lubrication and cooling system, braking, suspension, tire/track and steering system) including military vehicles; Emission effects and control; advanced electrical automotive drives and instruments; hybrid technology; Evaluating vehicle performance; Vehicle safety system and Vehicle tracking system including military vehicles. Vehicle electronics, sensors and imagining, signal processing and communications. Electromagnetics shielding of military vehicle.

Remark: Currently this course will be offered for EME officers of BD Army only, and later will be offered for civilian students.

Objective:

1. Extend current engineering knowledge towards their application within aspects of automotive science and the design of a modern land vehicle sub-system.
2. Develop the social awareness and responsibilities of the engineer in society.
3. Provide the opportunity to develop research competence and apply individual and independent thought to the understanding or solution to a problem through an advanced directed research project.
4. Provide the opportunity to apply high-level analytical software towards the design and packaging of complex assemblies.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Demonstrate knowledge on military vehicle design (requirements and guidelines)
2. Demonstrate knowledge on military vehicle subsystems.
3. Demonstrate advanced tracking and control system used in military vehicles.
4. Demonstrate knowledge on inspecting and maintenance of military vehicles.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy:

As convenient by the instructor.

Mapping of Course LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this course	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Demonstrate knowledge on military vehicle design	✓											
Demonstrate knowledge on military vehicle subsystems.	✓											
Demonstrate advanced tracking and control system used in military vehicles.	✓											
Demonstrate knowledge on inspecting and maintenance of military vehicles.	✓											

Reference Books:

1. Materials and Process Selection for Engineering Design - Mahmoud M. Farag
2. Automotive Mechatronics: Operational and Practical Issues - Fijalkowski, B. T.
3. Automotive Control Systems - A. Galip Ulsoy, Huei Peng, and Melih Çakmakci
4. Introduction to Hybrid Vehicle System Modeling and Control - Wei Liu
5. Automotive Chassis Systems - James D. Halderman
6. Automotive Brake Systems - James D. Halderman

Course Title: Advanced Electrical, Electronic and Communication Engineering

Course Code: EECE 6907

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to focus on the advanced and broad knowledge and skills relevant to a demanding and dynamic electronic and electrical engineering sector i.e., sensors and instrumentation, control systems, photonics, power electronics with applications to sustainable power systems, telecommunications, intelligent systems, medical systems, integrated circuits and embedded systems.

Course Contents:

Advanced trends in motor, generator, alternator and transformers, Analog and mixed signal IC design for wireless communication. Electronic vehicle system (control, drive and diagnoses system), PLC system and microprocessor based control system, Advanced technologies for electro-medical equipment, advanced wired and wireless communication system and trends in Military communication, high data rate analog and digital modulation techniques for Military communication system, fiber optic and free-space optical (FSO) communication and their applications in military, modern battle field surveillance system (IR, TI and LASER technology), control and stabilization technology, communication disruption and recording system in the battle field (ECM, ECCM etc). Electronic Protection, Support, Counter and Counter Counter measures (EPM, ESM, ECM and ECCM)

Remark: Both the instructor and students for this course will be from military.

Objective:

1. To develop in-depth knowledge in electrical and electronics engineering issues that will help to deal with new, complex and unusual challenges across a range of electrical and electronics issues.
2. To develop imagination, initiative and creativity to enable graduates for problem solving.

Learning Outcomes (LO): On successful completion of this course unit, students should be able to:

1. Demonstrate knowledge on advancement and current state of motor, generator, alternator and generator technology.
2. Demonstrate knowledge on advanced communication system used in militaries around the world
3. Demonstrate knowledge on modern battlefield surveillance equipment
4. Design PLC and microprocessor based control system for military application.

Teaching-learning Strategy: Class lectures, Case studies, Research papers review, Practical problem solution etc.

Assessment Strategy: Class tests, Assignments, Presentation and Final exam.

Mapping of Course LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this course	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Demonstrate knowledge on advancement and current state of motor, generator, alternator and generator technology.	✓											
Demonstrate knowledge on advanced communication system used in militaries around the world	✓											
Demonstrate knowledge on modern battlefield surveillance equipment	✓											
Design PLC and microprocessor		✓			✓							

based control system for military application.												

Reference Books:

1. Advanced Electrical and Electronics Engineering, Vol. 2 – Jian Lee
2. Electronic and Radio Engineeringm - F.E. Terman
3. Introduction to Programmable Logic Controllers - Glen Mazur and William J. Weindorf
4. Microcontroller programming - Julio Sanchez
5. Fiber Optic Communications: Fundamentals and Applications- M. Jamal Deen and Shiva Kumar

AEROSPACE DISCIPLINE

Course Title: Advanced Incompressible Fluid Dynamics

Course Code: AEAS 6111

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to focus on the incompressible flow and how it behaves and how we can explain their characteristics.

Course Contents:

Inviscid Incompressible flow, Viscous Incompressible flow: Laminar boundary layer (High Re), Stokes flow (Low Re), and Turbulent flow (Very high Re), Jets and wakes, Basic governing equations of fluid/aerodynamics i.e. Navier-Stokes equations and their analytical solution techniques, Solving two dimensional incompressible and inviscid flow using complex analysis treatment. Skin friction, separation, drag and Aerodynamic heating; Approximate and exact finite-difference solutions including the effect of suction and blowing; Solutions of turbulent boundary layer equations.

Objective:

1. To understand advanced knowledge of potential theory, as well as a fundamental understanding of the mechanics of incompressible flow.
2. To understand the fundamental conservation laws of fluid mechanics and how the theory of more specialized branches derives from these.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Explain and derive the basic conservation laws of fluid mechanics on differential form.
2. Apply tensor notation to describe flow kinematics and solve flow problems.
3. Explain and apply the analogy between momentum, heat and mass transfer.
4. Derive and solve simplified versions of the Navier-Stokes equations, such as the vorticity equation, Creeping/Stokes flow, potential flow, similarity solutions and the boundary layer equations.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy:

As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Explain and derive the basic conservation laws of fluid mechanics on differential form.	✓											
2. Apply tensor notation to describe flow kinematics and solve flow problems.						✓						
3. Explain and apply the analogy between momentum, heat and mass transfer.												
4. Derive and solve simplified versions of the Navier-Stokes equations, such as the vorticity equation, Creeping/Stokes flow, potential flow,				✓					✓			

similarity solutions and the boundary layer equations.												

Text and Ref Books:

1. The Navier-Stokes Equations - Hermann Sohr
2. Incompressible Computational Fluid Dynamics: Trends and Advances - Max D. Gunzburger and Roy A. Nicolaides
3. Analysis and Simulation of Fluid Dynamics - Caterina Calgaro, Jean-François Coulombel

Course Title: Advanced Compressible Fluid Dynamics

Course Code: AEAS 6112

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to focus on the compressible flow and how it behaves and how we can explain their characteristics.

Course Contents:

Classification and solution of compressible flow problems, basic conservation laws and fundamental theorems of compressible flows; Wave phenomena; normal and oblique shocks; Method of characteristics and wave interactions; Perturbation theories and similarity rules; Linearized supersonic flow, axisymmetric flow wing theory, and wave drag; Nonlinear theories of transonic and supersonic flows. Inviscid compressible flow: analysis of properties across shock / expansion wave, variable area flows, linearized 2-D flow, hypersonic flow and unsteady wave motion. Viscous compressible flow: solution of the complete system of governing equations including Navier-Stokes equations.

Objective:

1. To develop an analytical and physical understanding of the fundamental equations that govern fluid flow and solve them analytically in reduced form in a range of engineering and academic problems.
2. To apply the solutions of the reduced equation on relevant engineering problems and evaluate the validity of the solutions based on the respective assumptions made.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Understand how a viscous boundary layer develop at high mach numbers and calculate the velocity and temperature fields.
2. Calculate shock-wave propagation in two dimensions.
3. Understand the coupling between chemical reactions and flow in a gas.
4. Extend the thermodynamic concepts to high temperatures.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy:

As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Understand how a viscous boundary layer develop at high mach numbers and calculate the velocity and temperature fields.				✓								
2. Calculate shock-wave propagation in two dimensions.					✓							
3. Understand the coupling between chemical reactions and flow in a gas.			✓									
1. Extend the thermodynamic concepts to high temperatures						✓			✓			

Text and Ref Books:

1. Compressible Fluid Dynamics (Advanced engineering series) - Philip A. Thompson
2. Modern Compressible Flow: With Historical Perspective - John Anderson
3. The Dynamics and Thermodynamics of Compressible Fluid Flow- Ascher H. Shapiro

Course Title: Turbulent Fluid Flow and Turbulence Modeling

Course Code: AEAS 6113

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The course is broken into two parts. The first half covers the basic theoretical and physical descriptions of turbulence. In the second half, a wide range of turbulence models and simulation methods are presented and discussed. Topics include turbulence models typically used in commercial CFD codes as well as current research approaches.

Course Contents:

Laminar-turbulent transition, turbulent flow equations of motion; Definition of turbulence; Elementary turbulence modeling; coherent structure, and large-Eddy simulations; Longitudinal and lateral correlations inhomogeneous turbulence; Integral scales of turbulence; Eulerian space and time correlations; Lagrangian time correlations and diffusion; One- and three-dimensional energy spectrums; Hot-film anemometry.

Objectives:

1. Conduct an effective CFD simulation of an unsteady turbulent flow;

2. Understand the underlying flow physics; make a trade-off between different applicable LES models;
3. Select an appropriate grid resolution based on the flow physics;
4. Verify and visualize the simulation.

Learning Outcomes (LO):

1. Present a detailed theory of turbulence for canonical cases (homogeneous isotropic turbulence, free shear flows, wall-bounded shear flows,).
2. Present existing models and appreciate their limitations.
3. Apply the theory developed to various phenomena in fluid mechanics, in engineering and in geophysical and environmental fluid flows (atmosphere, oceans, estuaries, etc.).
4. Present an introduction to the numerical simulation of turbulent flows (RANS and LES).

Teaching-learning: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Present a detailed theory of turbulence for canonical cases (homogeneous isotropic turbulence, free shear flows, wall-bounded shear flows)	✓											
2. Present existing models and appreciate their limitations		✓										
3. Apply the theory developed to various phenomena in fluid mechanics, in engineering and in geophysical and environmental fluid flows (atmosphere, oceans, estuaries, etc.).			✓									
4. Present an introduction to the numerical simulation of turbulent flows (RANS and LES).					✓							

Text and Ref Books:

1. Tennekes H. and Lumley J.L., *A First Course in Turbulence*, The MIT Press, 1972
2. Pope S.B., *Turbulent Flows*, Cambridge University Press
3. Burchard H., *Applied Turbulence Modelling in Marine Water*, Springer VerlagCushman-Roisin B. and J.-M. Beckers, *Introduction to Geophysical Fluid Dynamics*, Academic Press, 2011

Course Title: Rotorcraft Aerodynamics

Course Code: AEAS 6114

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to serve as an introduction to the basics of rotorcraft aerodynamic-characteristics, components, structures, and avionics systems.

Course Contents:

History of rotary-wing aircraft, introduction to hovering theory, hovering and axial flight performance, factors affecting hovering and vertical flight performance, autorotation in vertical descent, concepts of blade motion and control, the aerodynamics of forwarding flight, forward flight performance, operational envelope, and introduction to rotor acoustics. Basic aerodynamic design issues associated with main rotors and tail rotors, discussion of detailed aerodynamic characteristics of rotor airfoils, modeling of rotor airfoil characteristics, review of classical methods of modeling unsteady aerodynamics, the problem of dynamic stall, review of methods of rotor analysis, physical description and modeling of rotor vertical wakes, discussion of aerodynamic interactional phenomena on rotorcraft, Flap dynamics. Mathematical methods to solve rotor dynamics problems. Flap-lag-torsion dynamics and identify structural and inertial coupling terms, Overview on rotary-wing unsteady aerodynamics, Basic theory of blade aeroelastic stability and ground and air resonance stability, vibration analyses and suppression, Design of helicopters and

similar rotary-wing aircraft, Design trend studies, configuration selection and sizing methods, performance and handling qualities analyses, structural concepts, vibration reduction and noise, Required independent design project conforming to a standard helicopter request for proposal (RFP), Development of helicopter simulation models and specifications of handling qualities, Methods for calculation of trim, poles, frequency response, and free flight response to pilot inputs.

Objectives:

1. The importance of helicopters as flying machines.
2. To prepare parametric studies for rotorcraft.
3. Understanding of the interrelationships that exist between the aerodynamics, structures, flight mechanics, stability and control when applied to helicopters.
4. Ability to define, calculate and understand the flapping motion.
5. Understanding of the stability and control when applied to helicopters.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Analysis of the behavior of rotor flapping motion of the helicopter blades
2. The use of flow conservation laws to develop analytic expressions for rotor downwash, rotor thrust, and power requirements
3. To analyze the stability of flight and the response to controls and atmospheric turbulences
4. To explore helicopter flight mechanics e.g. linear stability theory, eigenvalues/vectors, response solutions, an analytic expression

Teaching-learning: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Analysis of the behavior of rotor flapping motion of the helicopter blades.		✓										
2.The use of flow conservation laws to develop analytic expressions for rotor downwash, rotor thrust, and power requirements.	✓											
3.To analyze the stability of flight and the response to controls and atmospheric turbulences			✓									
4.To explore helicopter flight mechanics e.g. linear stability theory, eigenvalues/vectors, response solutions, an analytic expression					✓							

Text and Ref Books:

1. Seddon, J., 'Basic Helicopter Aerodynamics', B.S.P. Professional Books, 1990
2. Gessow, A., Meyers, G.C., 'Aerodynamics of the Helicopter', Dover Publication, (2nd edition of the first published book in 1952)
3. Padfield, Gareth D, "Helicopter Flight Dynamics", Blackwell Science, 1st edition 1996

4. Bramwell, A.R.S., ‘Helicopter Dynamics’, Edwards Arnold, 1976, the standard textbook of good quality, watch out for the misprints (Reprinted as ‘Bramwell’s Helicopter Dynamics’, by Butterworth-Heinemann, 2001)

Course Title: Computational Fluid Dynamics I

Course Code: AEAS 6115

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to use numerical methods and algorithms to solve and analyze problems that involve fluid flows.

Course Contents:

Introduction to CFD & thermo-fluids: Introduction to the physics of thermo-fluids; governing equations (continuity, momentum, energy and species conservation) and state of the art Computational Fluid Dynamics including modeling, grid generation, simulation, and high-performance computing; classification (elliptic, parabolic and hyperbolic PDEs), implicit and explicit methods, stability analysis, iterative and time/space marching schemes, grids, boundary conditions, various techniques of finite difference and finite volume techniques for solution of Navier-Stokes & Euler equations. Case study of an Industrial problem and the physical process that

CFD can be used to analyze. Computational Engineering Exercise: specification for a CFD simulation; Requirements for accurate analysis and validation for multiscale problems; Introduction to Turbulence & practical applications of Turbulence Models: Practical sessions: A fluid process problem will be solved employing the widely-used industrial flow solver software FLUENT; Lectures will be followed by practical sessions to set up and simulate a problem incrementally; Practical will cover the entire CFD process including geometric modeling, grid generation, flow solver, analysis, validation, and visualization.

Objectives:

1. To gain the knowledge and appreciation necessary for a strong foundation in this exciting engineering discipline.
2. To gain knowledge about computational methods with finite differences, finite volumes and finite elements for technical fluid flow problems.
3. To apply CFD methods as a tool for design, analysis and engineering applications.

Learning Outcomes (LO):

1. To reflect the wide applications of CFD in aerospace, turbomachinery
2. To use the applications of multiphase environmental flows and fluid-structure interaction problems.

Teaching-learning: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. To reflect the wide applications of CFD in aerospace, turbomachinery.	✓											
2. To use the applications of multiphase environmental flows and fluid-structure			✓									

interaction problems.												
3.To apply CFD methods as a tool for design, analysis and engineering applications.				✓								

Text and Ref Books:

1. An Introduction to Computational Fluid Dynamics: The Finite Volume Method (2nd Edition) 2nd Edition by H. Versteeg (Author).
2. Computational Fluid Dynamics 1st Edition by John Anderson

Course Title: Computational Fluid Dynamics II

Course Code: AEAS 6116

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to handle the accompanying heat and mass transfer problems. Methods for inviscid, viscous and turbulent flow regimes are presented, and the methods are equally applicable to two and three-dimensional flow configurations.

Course Contents:

Lax Method, Lax-Wendroff Method, ADI Method, Leapfrog method, Crank-Nikolson Method, Dispersion and Dissipation Errors, Beam and Warming Methods, Approximate factorization, Block tridiagonal matrices, Flux vector splitting, High-resolution schemes: TVD and Flux Limiters, Multigrid method, Adaptive meshing, Introduction to Turbulence and turbulent flows; Traditional

turbulence modeling, Advanced Turbulence Modelling, Introduction to Reynolds-averaged Navier Stokes equations (RANS) simulations and Large-eddy Simulation (LES).

Objectives:

1. To gain the knowledge and appreciation necessary for a strong foundation in this exciting engineering discipline.
2. Understand, write and apply CFD methods across a broad range of fields, from aerospace.
3. To apply CFD methods as a tool for design, analysis and engineering applications.

Learning Outcomes (LO):

1. To reflect the wide applications of CFD in aerospace, turbomachinery
2. To use the applications of large equation systems, multigrid, Krylov methods, turbulence modeling, implementation of models in fluid programs, limitations of different turbulence models for describing important fluid flow phenomena

Teaching-learning: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. To reflect the wide applications of CFD in aerospace, turbomachinery.	✓											
2. To use the applications of multiphase environmental flows and fluid-structure interaction problems.			✓									

3. Understand, write and apply CFD methods across a broad range of fields, from aerospace.		✓										

Text and Ref Books:

1. Computational Fluid Mechanics and Heat Transfer (Computational and Physical Processes in Mechanics and Thermal Sciences) 3rd Edition by Dale Anderson, John C. Tannehill, Richard H. Pletcher
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method (2nd Edition) 2nd Edition by H. Versteeg (Author).
3. Computational Fluid Dynamics 1st Edition by John Anderson

Course Title: Flight Dynamics and Control

Course Code: AEAS 6117

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The main course's objective is to teach students about the stability, the trim and the control characteristics of the aircraft.

Course Contents:

Static stability and trim, stability derivatives and characteristics longitudinal and lateral-directional motions, and physical effects of wings, fuselage and tail on aircraft motion, Flight vehicle stabilization by classical and modern control techniques, time and frequency domain analysis of control system performance, human-pilot models, and pilot-in-the-loop controls with applications,

Parameter sensitivity and handling quality analysis of aircraft through variable flight conditions, Introduction to non-linear flight regimes.

Objectives:

1. To define the longitudinal static stability of the aircraft.
2. To determine the longitudinal control of the aircraft.
3. To derive the equation of motion of the aircraft.
4. To solve the longitudinal equations of motion which result in an exact description of the stability and response characteristics of the aircraft.
5. Explain the difference between, and factors affecting static and dynamic stability

Learning Outcomes (LO):

1. Explain the difference between, and factors affecting static and dynamic stability.
2. Describe aircraft dynamic modes.
3. Analyze contribution of various aircraft components to longitudinal, directional and lateral stability.

Teaching-learning: Lectures, class performances, assignments, Class tests, final exam

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Explain the difference between, and factors affecting static and dynamic stability.	✓											
2. Describe aircraft dynamic modes.			✓									

3. Understand, write and apply CFD methods across a broad range of fields, from aerospace.						✓						

Text and Ref Books:

1. Aircraft Performance Stability and Control, Vol-I, - James D; Lang the United States Air force Academy.
2. Automatic Control of Aircraft and Missiles - Col. John H, Blakelock
3. Airplane Performance, Stability, and Control - Perkins, and Hage
4. Dynamics of Flight – Bernard Etkin

Course Title: Potential Flow and Panel Method

Course Code: AEAS 6118

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

This course emphasizes the fundamental underlying fluid mechanical principles and application of those principles to solve real-life problems. Special attention is given towards deriving all the governing equations starting from the fundamental principle.

Course Contents:

Introduction, Different forms of fluid dynamics equations, Fundamentals of inviscid, incompressible flows, General Solution of the incompressible, Potential flow equations, Exact solution with complex variables, Numerical (Panel) Methods, Singularity elements, and Influence coefficients, Two-dimensional numerical solutions, Three-dimensional numerical solutions, Enhancement of Potential Flow Models.

Objectives:

1. Understanding the Fluid Mechanics: Fluid Kinematics
2. Understanding the concepts of Fluid Mechanics: Dynamics of Inviscid Flows and Reynolds Transport Theorem.
3. To analyze the solutions of the Navier-Stokes equation – Steady Flows (contd) and Practical Applications.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Investigate inviscid potential flows around bodies.
2. Analyze the High speed compressible flows through nozzles and pipe.
3. Understanding the Choked flow and shocks
4. Evaluate the Enhancement of Potential Flow Models.

Teaching-learning: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Investigate inviscid potential flows around bodies.		✓										
2. Analyze the High-speed compressible flows through nozzles and pipes.	✓											
3. Understanding the Choked flow and shocks			✓									
4. Evaluate the Enhancement of Potential Flow Models.					✓							

Text and Ref Books:

1. Advanced Fluid Mechanics 1st Edition by William Graebel
2. Potential Flow Panel Methods for the Calculation of Free-surface Flows with Lift Paperback – 1997 by Carl-Erik Janson
3. Advanced Mechanics of Fluids Hardcover – December 1959 by Hunter Rouse (Editor)

Course Title: Experimental Techniques in Fluid and Thermal Sciences

Course Code: AEAS 6119

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

Through this program, students will acquire the scientific and technological knowledge, as well as the practical experience, understand and contribute to innovative research and development processes.

Course Contents:

Introduction, Different forms of fluid dynamics equations, Fundamentals of inviscid, incompressible flows, General Solution of the incompressible, Potential flow equations, Exact solution with complex variables, Numerical (Panel) Methods, Singularity elements, and Influence coefficients, Two-dimensional numerical solutions, Three-dimensional numerical solutions, Enhancement of Potential Flow Models.

Objectives:

1. Advanced understanding of heat and fluid flow processes and their role in modern methods of power generation
2. In-depth understanding of numerical and experimental techniques in heat and fluid flow
3. To enhance their expertise in thermofluids.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. To provide insight through experimentally observed phenomena
2. To provide practical/computational experience of a wide range of measurement and data analysis techniques.
3. Able to design, development and testing of internal combustion engines, turbines or power-producing devices.

Teaching-learning: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Investigate inviscid potential flows around bodies.		✓										
2. Analyze the High-speed compressible flows through nozzles and pipes.	✓											
3. Understanding the Choked flow and shocks			✓									
4. Evaluate the Enhancement of Potential Flow Models.					✓							

Text and Ref Books:

1. Advances in New Heat Transfer Fluids: From Numerical to Experimental Techniques 1st Edition, Kindle Edition by Alina Adriana Minea
2. Fundamentals of Thermal-Fluid Sciences 5th Edition by Yunus Cengel (Author), Robert Turner (Author), John Cimbala (Author)

Course Title: Hypersonic/High-Temperature Gas Dynamics

Course Code: AEAS 6120

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to design and to know the operation of high-speed aerospace vehicles, such as launch vehicles, re-entry vehicles and missiles.

Course Contents:

General flow relations in the high Mach number limit, Hypersonic similitude and Mach number independence, Power-law similarity solutions and the blast-wave analogy, Newtonian flow Surface inclination methods and method of characteristics, Shock-wave reflections and interactions, Hypersonic boundary layers and transition, Viscous interactions Hypersonic facilities and experimental methods. Introductory kinetic theory, chemical thermodynamics and statistical mechanics, The ideal dissociating gas (IDG): equilibrium and non-equilibrium, Vibrational non-equilibrium, Normal and oblique shocks, Propagation of sound waves Nozzle flows Curved

shocks/blunt-body flows Viscous flows/chemically reacting boundary layers, Radiative gas dynamics, Facilities for simulating high-temperature flows.

Objectives:

1. Understanding the General flow relations in the high Mach number limit
2. To analyze the Newtonian flow Surface inclination methods and method of characteristics
3. To understand Normal and oblique shocks.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. The fundamental features of hypersonic flows, and how these differ from other flows.
2. The importance and influence of non-equilibrium real-gas effects in high-temperature flow.
3. How the above influence the design of hypersonic vehicles.
4. Computational methods appropriate to high speed and/or high-temperature flows.

Teaching-learning: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. The fundamental features of hypersonic flows, and how these differ from other flows			✓									
2. The importance and influence of non-equilibrium real-gas effects in high-temperature flow	✓											
3. How the above influence the design of hypersonic vehicles		✓										
4. Computational methods appropriate to high speed and/or high-temperature flows				✓								

Text and Ref Books:

1. Anderson. J.D. Modern Compressible Flow, with Historical Perspective.
2. Laney, C.B. Computational Gasdynamics.
3. Anderson.J.D. Hypersonic & High-Temperature Gas Dynamics.

Course Title: Rarefied Gas Dynamics / Kinetic Theory

Course Code: AEAS 6121

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The course is about microscopic approach to understanding the behavior of a gas which states that all substances are composed of a large number of very small particles (molecules or atoms). The observable properties of gas are the consequence of the actions of the molecules making up the gas.

Course Contents:

The Molecular Models, Binary Elastic Collisions, Basic Kinetic Theory of Gases, Equilibrium Gas Properties, Inelastic Collisions and Surface Interactions, Collision less Flows, Analytical Methods for Transition Regime Flows, Numerical Methods for Transition Regime Flows, Kinetic Model Boltzmann Equations, Direct Simulation Monte Carlo Method, Applications to Satellite Aerodynamics and Micro geometric Flows, Applications to Vacuum Pumps and Plasma Processing in Microelectronic Industries.

Objectives:

1. To understand the modular models.
2. To analyze the Numerical Methods for Transition Regime Flows.
3. Understading Applications to Satellite Aerodynamics and Micro geometric Flows
4. To evaluate the problems related to Vacuum Pumps and Plasma Processing in Microelectronic Industries

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Calculate basic gas properties such as temperature, pressure, flow velocity, gas stresses and fluxes from the molecular velocity distribution function.
2. Identify gas flow regimes (continuum, slip, transitional, free molecular) and applicable governing equations.
3. Apply equilibrium fluxes to solve basic free-molecular flow problems.
4. Setup and conduct direct simulation Monte Carlo modeling for rarefied flow problems.

Teaching-learning: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Calculate basic gas properties such as temperature, pressure, flow velocity, gas stresses and fluxes from the molecular velocity distribution function.			✓									
2. Identify gas flow regimes (continuum, slip, transitional, free molecular) and applicable governing equations.		✓										
3. Apply equilibrium fluxes to solve basic free-molecular flow problems.	✓											
4. Setup and conduct direct simulation Monte Carlo modeling for rarefied flow problems.				✓								

Text and Ref Books:

1. Kinetic Theory of Gases (Dover Books on Chemistry) Reprint Edition by Walter Kauzmann
2. Kinetic Theory and Transport Phenomena (Oxford Master Series in Physics) 1st Edition by Rodrigo Soto

Course Title: Advanced Heat Transfer

Course Code: AEAS 6122

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The course is about the microscopic approach to understanding the behavior of a gas which states that all substances are composed of a large number of very small particles (molecules or atoms). The observable properties of the gas are the consequence of the actions of the molecules making up the gas.

Course Contents:

Un-steady heat conduction in one or more dimensions, steady conduction in multidimensional configurations, numerical simulation of conduction; forced convection in laminar and turbulent flows; natural convection in internal and external configurations; heat transfer during condensation and boiling; mass transfer at low rates, evaporation; thermal radiation, black bodies, grey radiation

networks, spectral and solar radiation. Problems and examples will emphasize the modelling of complex systems drawn from manufacturing, electronics, consumer products, and energy systems.

Objectives:

1. To understand the heat conduction in one or more dimensions
2. To analyze the steady conduction in multidimensional configurations
3. Understanding heat transfer during condensation, boiling and mass transfer at low rates

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Explain various aspects regarding transport/transfer of mass, momentum, energy, and chemical components in fluid mixtures or between phases.
2. Perform basic computations on transport/transfer of mass, momentum, and energy in idealized (sub-)systems, e. g. by application of boundary layer theory or correlations for energy and mass transfer.
3. Choose necessary actions for the incorporation of chemical reaction kinetics as well as treatment of particles, droplets and bubbles in the overall global conservation equations for mass, momentum and energy.
4. Formulate and analyze problems involving radiation in multi-surface systems

Teaching-learning: Lectures, class performances, assignments, Class tests, Final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Explain various aspects regarding transport/transfer of mass, momentum, energy, and chemical components in fluid mixtures or between phases.	✓											
2. Perform basic computations on transport/transfer of mass, momentum, and energy in idealized (sub-)systems, e. g. by application of boundary layer theory or			✓									

correlations for energy and mass transfer.												
3. Choose necessary actions for the incorporation of chemical reaction kinetics as well as treatment of particles, droplets, and bubbles in the overall global conservation equations for mass, momentum and energy.				✓								
4. Formulate and analyze problems involving radiation in multi-surface systems		✓										

Text and Ref Books:

1. M.F. Modest. Radiative Heat Transfer. Academic Press, San Diego, 2013.
2. G. Nellis, S. Klein. Heat transfer, Cambridge, 2008.
3. A. Faghri, Y. Zhang, J. Howell. Advanced heat and mass transfer. Global Digital Press, 2010.

Course Title: **Advanced Hydrodynamic Stability**

Course Code: **AEAS 6123**

Level: **Post Graduation Program**

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: Gathering knowledge and explanation for hydrodynamic analysis

Course Synopsis: Laminar-stability theory as a guide to laminar-turbulent transition, equation, instability criteria, and response to small inviscid disturbances. Discussion of Kelvin-Helmholtz, Rayleigh-Taylor, Richtmyer-Meshkov, and other instabilities, for example, in geophysical flows. The Orr-Sommerfeld equation, the dual role of viscosity, and boundary-layer stability. Modern concepts such as pseudomomentum conservation laws and nonlinear stability theorems for 2-D and geophysical flows. Weakly nonlinear stability theory and phenomenological theories of turbulence

Learning Outcomes (CO):

Upon completion of the course, the students will be able to:

1. Understand and identify indicators and metrics of instability
2. Analyze the stability of hydrodynamic systems
3. Evaluate the influence of real-world, engineering conditions (noise, imperfect experimental conditions, etc.) on flow stability
4. Expound a working knowledge of current analytical and numerical techniques to characterize hydrodynamic instability

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy:

As convenient by instructor.

Linkage of CO with Assessment Methods& their Weights:

As convenient by instructor

Mapping of Course Outcome and Program Outcomes:

Course Outcome (CO) of the Course	**Program Outcomes* (Appendix-1)**											
	1	2	3	4	5	6	7	8	9	10	11	12
1 Understand and identify indicators and metrics of instability	√											
2. Analyze the stability of hydrodynamic systems	√											
3. Evaluate the influence of real-world, engineering conditions (noise, imperfect experimental conditions, etc.) on flow stability	√											
4. Expound a working knowledge of current analytical and numerical techniques to characterize hydrodynamic instability		√										

DIVISION OF AEROSTRUCTURE

Course Title:	Advanced Aircraft Structures
Course Code:	**AEAS 6131**
Level:	**Post graduation program**
Credit Hour:	3.0
Contact Hour:	3.0
Rationale:	Explain and analyzing advanced aircraft structures.

Course Synopsis:

Variational Methods in Structural Mechanics: Preliminaries, Introduction to the calculus of variations; transformation of the stress and strain tensors. Axioms: Hamilton's Principle and the Principle of Virtual Work. Kinematic and natural boundary conditions. An introduction to dynamics of rods and beams. Applications to aerospace structures. Flat Plates:Variational treatment of the mechanics of rectangular plates subjected to transverse suction loading and/or in-plate loading. Kirchoff's shear and variationally consistent set of boundary conditions, Levy's method.

Rayleigh-Ritz solution using assumed approximate modes; critical buckling stress, Fibre-Reinforced Composites: The stress-strain relations for specially orthotropic and generally orthotropic laminate; analysis of layered laminates subjected to extensional and bending stresses, Structural Idealization: Boom-skin models of stiffened structures such as the fuselage and the wing, Shear flow in idealized thin-walled sections. Shear lag in thin walled structures.

Learning outcomess (CO):

Upon completion of the course, the students will be able to:

1. Explain fundamental concepts in the analysis of flight structures.
2. Evaluate stress distribution in aircraft components.
3. Create an appreciation for the design and sizing of aircraft structural configurations subjected to various load combinations.

Teaching-learning: Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by instructors

Linkage of CO with Assessment Methods& their Weights: As convenient by instructors

Mapping of Learning outcomes and Program Outcomes:

Learning outcomes (CO) of the Course	**Program Outcomes* (Appendix-1)**											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Explain fundamental concepts in the analysis of flight structures.	√											
2. Evaluate stress distribution in aircraft components.		√										
3. Create an appreciation for the design and sizing of aircraft structural configurations subjected to various load combinations.				√								

Text and Ref Books:

1. Aircraft Structures for Engineering Students- T.H.G Megson

2. Aircraft Structure –David & Perez; Publisher – McGraw-Hill.

3. Strength of Materials (**4th edition**) – Andrew Pytel, Ferdinand L. Singer.

4. Strength of Materials –Beer and Johnston.

Grading System: As per the approved grading scale of MIST.

Student's responsibilities: Students must come to the class prepared for the course material covered in the previous class(es). They must submit their assignments on time. They must be aware of the *Plagiarism Policy* as spelt out in the curriculum. No late or partial assignments will be acceptable.

Course Title: Advanced Theory of Vibrations

Course Code: AEAS 6132

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

To teach students how to use the theoretical principles of vibration and vibration analysis techniques, for the practical solution of vibration problems. In keeping with the applied focus, the course includes practical analysis and measurement activities and a project in which students play the roles of clients and consultants while solving a real vibration problem.

Course Contents:

Basic concepts, spring, mass and damper elements, harmonic motion and its analysis, Free and Forced vibrations of single degree of freedom (SDOF) system, damped and undamped system, two and multi-degrees of freedom system.

Objective:

The objective of this course is to cover comprehensive fundamental principles of vibration theory

1. To give basic knowledge on different types mechanical vibrations.
2. Formulate mathematical models of problems in vibrations.
3. Determine a complete solution to mechanical vibration problems using mathematical or numerical techniques, and
4. Determine physical and design interpretations from the results.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Explain the principles of vibrations.
2. Describe the principles of the advanced vibration modelling and analysis techniques, e.g. frequency response functions and Finite Element analysis.
3. Explain the operating principles of common vibration measurement tools and of signal analysis techniques.
4. Evaluate natural frequency and period of simple vibrating mechanical systems and obtain the analytical solution for system's time response.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Explain the principles of vibrations	✓											

2.Describe the principles of the advanced vibration modelling and analysis techniques, e.g. frequency response functions and Finite Element analysis.			✓									
3.Explain the operating principles of common vibration measurement tools and of signal analysis techniques.					✓							
4.Evaluate natural frequency and period of simple vibrating mechanical systems and obtain the analytical solution for system's time response.		✓										

Text and Ref Books:

1. Inman, Daniel J., Engineering Vibration, Prentice Hall, Second Edition, 2001
2. Leonard Meirovitch, Fundamentals of Vibrations, McGrawHill, (any edition)
3. Jon J. Thomsen, Vibrations and Stability, Springer, Second Edition, 2003

Course Title: Design and Analysis of Composites

Course Code: AE 6133

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to provide knowledge in design and analysis of advanced lightweight and composite structures in aerospace, automotive, marine and renewable energy industries. Delivered with a unique focus on industry challenges and concerns, this course will equip students with strong experimental, numerical and analytical skills in structural mechanics for both composite and metallic components. This will help them to practically apply this knowledge to solve real engineering problems.

Course Contents:

Introduction; Types of composite materials, especially FRP composites; Overview of composites manufacturing techniques; Micromechanics and macromechanics for stiffness and strength analysis of a FRP ply; Macromechanics, constitutive equation, stiffness and strength analysis of a FRP laminate; Thermal and moisture residual stresses in a FRP laminate; Buckling aspects of laminate plates; Sandwich panels with FRP composite facing skins; Stress analysis of an open and closed section FRP composite structure subjected to various loadings.

Objective:

1. Describe the concept of composites and their applications in engineering.
2. Use basic principles and means for design and analysis of simple structures made of composites.
3. Introduce the concept of polymer, classification, major thermo-physical properties.
4. Familiarise with a range of typical manufacture processing techniques.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Basic knowledge of composites and understanding of the design and analysis of composite structures and manufacturing.
2. Demonstrate understanding of mechanics of composite materials and structures, fracture and failure mechanisms as applied to simple component design.
3. Be able to apply concepts, theories and methods for analysis and design of composite structures to real-life applications.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12

1. Basic knowledge of composites and understanding of the design and analysis of composite structures and manufacturing.	✓											
2. Demonstrate understanding of mechanics of composite materials and structures, fracture and failure mechanisms as applied to simple component design.		✓										
3. Be able to apply concepts, theories and methods for analysis and design of composite structures to real-life applications.			✓									

Text and Ref Books:

1. "Design and Analysis of Composite Structures" by C. Kassapoglou
2. "Engineering Mechanics of Composite Materials" by Ishai, Ori and Daniel, Isaac (2006)
3. "Mechanics of Composite Materials" by Robert M. Jones (1999)

Course Title: Finite Element Methods and Analysis

Course Code: AE 6134

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to study algorithms for solving ordinary differential equations, nonlinear systems, and optimization problems. The analysis and implementation of these algorithms will be discussed in some detail.

Course Contents:

Introduction to the Finite Element Method as applied to one and two dimensional problems of structures, heat transfer and fluid flow. Introduction: general overview of the technique, pre-processing, solution and post-processing, basic terminology, range of applications, basic introduction to materials modeling; Pre-processing: Introduction to IDEAS, introduction to MSC. Patran, connectivity between different packages; FE for linear elasticity: element types (bars, beams, 2D, 3D, shell elements), one- and multi-dimensional analysis, meshing, symmetry, model development in MSC. Patran, application of boundary conditions, solution in MSC. Nastran/Marc; FE for field problems: analysis of heat transfer problems, equivalence with other field problems, convergence, boundary conditions, model development and solution for field problems in MSC. Patran/Nastran/Marc; FE for advanced analysis: geometric non-linearity, material non-linearity, contact problems, FE for dynamic problems, explicit solution using PAMCRASH, non-linear modelling using MSC. Patran/Nastran/Marc; Materials modelling: Abnitio modeling, Monte Carlo and molecular dynamics simulation, phase diagrams, diffusion-kinetics-microstructure; Application of finite element analysis to design: optimization using FE, model uncertainty, variability and Monte Carlo simulation; Typical application areas include aerospace, automotive, impact, composites.

Objective:

1. Apply vector mechanics as a tool for problem solving
2. Understand the need in Design for the Finite Element Method
3. Tie his/her understanding of mechanical engineering design concepts to use the Finite Element Method software correctly and efficiently
4. Analyze a physical problem, develop experimental procedures for accurately investigating the problem, and effectively perform and document findings
5. Understand forces associated with different parts of a machine

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Understand the numerical methods involved in Finite Element Theory
2. Understand direct and formal (basic energy and weighted residual) methods for deriving finite element equations
3. Analyze the formulation of one-dimensional elements (truss and beam)
4. Formulation of two-dimensional elements (triangle and quadrilateral continuum and shell elements)
5. Formulation of three-dimensional elements (tetrahedral and brick elements)
6. Perform and verify FEA using commercial FEA software

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Understand the numerical methods involved in Finite Element Theory	✓											
2.Understand direct and formal (basic energy and weighted residual) methods for deriving finite element equations	✓											
3.Analyze the formulation of one-dimensional elements (truss and beam)		✓										
4.Formulation of two-dimensional elements (triangle and quadrilateral continuum and shell elements)		✓										
5.Formulation of three-dimensional elements (tetrahedral and brick elements)		✓										
6.Perform and verify FEA using commercial FEA software					✓							

Text and Ref Books:

1. K. Bathe, Finite Element Procedures, 1st Ed., Prentice Hall, 1996.
2. T.R. Chandrupathla, Introduction to Finite Elements in Engineering, 2nd Ed, Prentice Hall, 1997.
3. A. Askenazi, V. Adams, Building Better Products with Finite Element Analysis, 1997.
4. R.D. Cook, et al., Concepts and Applications of Finite Element Analysis, 1996.

5. G.R. Buchanan, Schaum's Outline of Finite Element Analysis (Schaum's), 1996.
L.J. Segerlind, Applied Finite Element Analysis, 1984

Course Title: Tribology

Course Code: AE 6135

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The key goal of the course is to provide the students with the high-level contemporary knowledge, required for the next generation of engineers to tackle highly-interdisciplinary tribology-related problems through an interdisciplinary and complementary joint master programme about tribological surfaces, interfaces, lubricants, lubrication, as well as wear and friction mechanisms at nano and macro scale, and computational, modelling, analytical and experimental skills.

Course Contents:

Fundamentals of tribology; Engineering surfaces - characterization and statistical description of engineering surfaces; Mechanics of contact - Hertz theory and GW model; Friction and wear; Thermal effects in sliding contact. Lubrication and lubricants; Rheology of lubricants;Regimes of lubrication; Theory and application of hydrodynamic lubrication; Boundary friction and extreme pressure lubrication; Elasto-hydrodynamic lubrication (EHL) theory; Rolling element bearings; Nanotribology.

Objective:

1. To introduce students to the field of tribology.
2. Demonstrate basic understanding of friction, lubrication, and wear processes.
3. Familiar with mathematical tools used to analyze tribological processes.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Familiarize with common anti-friction and anti-wear components and the lubricants used therein.
2. Design a tribological system for optimal performance.
3. Study engineering problems related to friction, wear, and lubrication.
4. Selection of lubricants and lubrication processes according to system function.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Familiarize with common anti-friction and anti-wear components and the lubricants used therein.	✓											

2.Design a tribological system for optimal performance.			✓									
3.Study engineering problems related to friction, wear, and lubrication.				✓								
4.Selection of lubricants and lubrication processes according to system function.					✓							

Text and Ref Books:

1. Engineering Tribology by John A. Williams.
2. Engineering Tribology by Stachowiak, Batchelor.
3. Tribology, Principles and Design Applications, by Arnell et al.
4. Fundamentals of Machine Elements, by Hamrock, Jacobson, and Schmid
5. Principles and Applications of Tribology, by B. Bhushan
6. Tribology Handbook, by B. Bhushan
7. Fluid Film Lubrication, By B. Hamrock

Course Title: Advanced Theory of Elasticity

Course Code: AE 6136

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

At the end of the course, the student should be able to design and analyze engineering components subject to different types of loading. In particular, the objective is to introduce the student to the methods of stress, deformation and stability analysis, failure theories and fatigue analysis.

Independent learning, professionalism and applications to real engineering applications and problems will be stressed throughout.

Course Contents:

Theory of elasticity, Index notation, Cartesian Tensor analysis, coordinates transformations, analysis of stress, Sign convention, Cauchy formula components of traction vector, results of conservation laws, principal stresses and direction, spherical and deviatoric stresses, analysis of deformation, displacement and strain, infinitesimal deformation theory, geometric meaning of strain components, principal strain and directions, spherical and deviatoric strains, compatibility equations, anisotropy, constitutive equation for a linear isotropic elastic solid, physical meaning of the elastic modulii, thermal stress and strain, basic field equations, stress and displacement formulations, two dimensional elasticity, plane stress and strain problems, fundamental solution strategies, Airy stress function, solution using polynomial approach, torsion of prismatic bars, Prandtl stress functions, Fourier transformation method and St.Venant's principle, Solution to plates of various profiles and end conditions along with the most commonly used numerical energy methods.

Objective:

1. To introduce theoretical fundamentals of theory of elasticity
2. Derive the governing equations for 2D and 3D elastic problems
3. Analyze some real problem and to formulate the conditions of theory of elasticity application
4. Execute a reasonable choice of parameters of the model (geometry, material properties, boundary conditions)

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Indicial notation and Cartesian tensor analysis
2. Analysis of stress and deformation
3. Use the numerical methods for the problem of the theory of elasticity in practice
4. Formulations and solution strategies of various boundary value problems

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Indicial notation and Cartesian tensor analysis	✓											
2.Analysis of stress and deformation		✓										
3.Use the numerical methods for the problem of the theory of elasticity in practice			✓									
4.Formulations and solution strategies of various boundary value problems		✓										

Text and Ref Books:

1. Theory of Elasticity 3rd Edition by Trimoshenko and Goodier
2. Introduction to Linear Elasticity, P.L. Gould, 1983, Springer.
3. Elasticity, J.R. Barber, 1992, Kluwer.
4. Elasticity in Engineering Mechanics, A.P. Boresi, 2000, Wiley.

Course Title: Loading Actions

Course Code: AE 6137

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to provide a comprehensive overview of forces, loads and factors of whole aircraft configuration as well as structures and systems. A holistic teaching approach is taken

to explore how the individual elements of an aircraft can be designed and integrated using up-to-date methods and techniques.

Course Contents:

Standard requirements, their application, interpretation and limitations; Flight loading cases: symmetric maneuvers, pitching acceleration, gust effects, asymmetric maneuvers, roll and yaw; Balance equations: rigid airframe response, control movements and forces; Ground loading cases: Air load distributions; Structural design data: Inertia relief shear force, bending moment and torque diagrams; Factors: load factors, their basis and restrictions, repeated and random loads.

Objective:

1. To understand the loading actions acting on an aircraft
2. To derive the equations which govern the elastic response of the airframe, statically and dynamically
3. Critically examine the solution of numerical problems against acquired knowledge
4. To solve problems systematically

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Understanding and predicting the mutual interactions between different fields (aerodynamics, structural dynamics, etc.).
2. Derive from first principles the mathematical laws which govern the loads produced by gusts and symmetric aircraft manoeuvres, with particular reference to wing loads.
3. Provide analytical and numerical tools to analyze complex aerospace systems within a multidisciplinary environment.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy:

As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Understanding and predicting the mutual interactions between different fields (aerodynamics, structural dynamics, etc.).	✓											
2.Derive from first principles the mathematical laws which govern the loads produced by gusts and symmetric aircraft manoeuvres, with particular reference to wing loads.		✓										
3.Provide analytical and numerical tools to analyze complex aerospace systems within a multidisciplinary environment					✓							

Text and Ref Books:

1. Da Ronch. Aircraft Structural Design.
2. J.R. Wright and J.E. Cooper. Introduction to Aircraft Aeroelasticity and Loads.
3. T.H.G. Megson. Aircraft Structures for Engineering Students.

Course Title: Design for Manufacture and Operation

Course Code: AEAS 6138

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The main course's objective is to teach students the methodology and decision makinginvolved in the process of designing aircraft.

Course Contents:

Wing configuration and manufacture; Fuselage layout and manufacture; Undercarriage: Shock absorbers and leg geometry, detail considerations; Flaps and control surfaces: Structural configuration and mechanisms; Assembly and production processes; Maintainability and accessibility.

Objective:

1. To describe an aircraft design phase like conceptual, preliminary and detail
2. To generate a first estimation of the new aircraft weight
3. To analyze the critical performance parameters for the new aircraft
4. To generate the configuration layout for the new aircraft
5. To understand the detail design phase and analyzing the wing design, tail design, fuselage design, propulsion system design.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Understand and experience of design of an aerospace system, mission, or vehicle.
2. Apply the knowledge of fundamentals of aeronautics with different disciplines.
3. Understand the conceptual design phase, design layout and design analysis - various types and categories of aircraft, requirement of teamwork for complex engineering projects.
4. Understand the preliminary design phase and evaluating Max take-of weight (MTOW), wing area& engine sizing.
5. Understand the detail design phase and analyzing the wing design, tail design, fuselage design, propulsion system design.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy:

As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**

	1	2	3	4	5	6	7	8	9	10	11	12
1. Understand and experience of design of an aerospace system, mission, or vehicle.						✓						
2. Apply the knowledge of fundamentals of aeronautics with different disciplines.	✓											
3. Understand the conceptual design phase, design layout and design analysis - various types and categories of aircraft, requirement of teamwork for complex engineering projects.		✓										
4. Understand the preliminary design phase and evaluating Max take-of weight (MTOW), wing area& engine sizing.		✓										
5. Understand the detail design phase and analyzing the wing design, tail design, fuselage design, propulsion system design.			✓									

Text and Ref Books:

1. Aircraft Design: A systems of Engineering Approach- Mohammad H. Saddaey
2. Aircraft Design: A Conceptual Approach - Raymer, 3rd Ed; AIAA Virginia, 1999.
3. Airplane Design: John Roskam, Parts

Course Title: Fatigue Fracture Mechanics and Damage Tolerance

Course Code: AEAS 6139

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The course introduces the students to the terminology, principles, methods and practice used to safeguard structures against fracture and fatigue failures. In particular, the course teaches students to perform “damage tolerance analysis” of structures that are pertinent in design of advanced structures such as aerospace, naval, automobile structural components.

Course Contents:

Design awareness: Philosophies of design against fatigue: i.e. safe-life, fail-safe and damage tolerance; Fatigue analysis: The traditional S-N curve approach: calculation of crack initiation life; mean stress effect, notch effect, and other influential factors; Palmgren-Miner's cumulative damage rule and fatigue analysis under variable amplitude loadings; Aircraft fatigue loads: Atmospheric turbulence, maneuver, landing and ground loads; determination of cumulative frequency load distribution; typical aircraft load spectra which have been developed for use in the laboratory and computer simulation; Fracture Mechanics: Basic Theory of Linear Elastic Fracture Mechanics (LEFM): concepts of Stress Intensity Factor, fracture toughness, energy release rate; plane stress and plane strain, plastic zone at the crack tip; calculation of residual strength for a component containing cracks; prediction of fatigue crack growth using the Paris law and Forman's formula; Damage Tolerance: Damage tolerant design methods; fatigue monitoring in flight/service; inspection methods: CAA and FAA Regulations and their relationship to Airworthiness Certification.

Objective:

6. To understand of the influence of cracks and flaws on the performance of structural materials subject to mechanical loads
7. To learn how to quantitatively predict and prevent the failure of materials that contain cracks or flaws.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Correctly apply linear elastic fracture mechanics (LEFM) to predict material failure
2. Identify and describe the basic fracture and fatigue mechanisms and apply that knowledge to failure analysis
3. Correctly determine the linear elastic fracture toughness, K_{IC}, of a material from experimental data
4. Correctly predict lifetimes for fatigue and environmentally assisted cracking

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy:

As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Correctly apply linear elastic fracture mechanics (LEFM) to predict material failure					✓							
2.Identify and describe the basic fracture and fatigue mechanisms and apply that knowledge to failure analysis	✓											
3.Correctly determine the linear elastic fracture toughness, K_{IC}, of a material from experimental data		✓										
4.Correctly predict lifetimes for fatigue and environmentally assisted cracking							✓					

Text and Ref Books:

1. Anderson T L, “Fracture Mechanics: Fundamentals and Applications”, 4th Edition, CRC Press, 2005.
2. ASTM Standard E399, “Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness K_{Ic} of Metallic Materials,” ASTM International.
3. Richard Hertzberg, “Deformation and Fracture Mechanics of Engineering Materials,” John Wiley and Sons.

Course Title: Advanced Aero-Elasticity

Course Code: AEAS 6140

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

This course serves as an introduction to the field of aeroelasticity. The course starts with a short review of the foundations of low-speed aerodynamics and vibration analysis. The students will then be presented with a qualitative overview of static and dynamic aeroelastic phenomena typical of hypersonic flows. Some numerical analysis techniques suitable for obtaining approximate solutions will also be introduced.

Course Contents:

Introduction (historical review, aero-elastic phenomena and design requirements); Structural and aerodynamic stiffness; Static aeroelasticity: torsional divergence, control effectiveness and reversal; Structural vibration and modal analysis; Aerodynamic loads on an oscillating lifting surface; Characteristics of flutter and important design parameters; Methods for aeroelastic analysis (divergence and flutter speed prediction); Gust response of rigid and flexible airframes; This module has additional accompanying tutorials and computer workshops as required.

Objective:

1. To introduce with the physical processes which drive aeroelastic phenomena
2. To formulate and solve aeroelastic response and instability problems
3. To identify strengths and weaknesses of different aerodynamic and structural models for the analysis of a given aeroelastic condition
4. To be familiar with the role of aeroelasticity in aircraft design
5. To be able to carry out aeroelastic calculations using software

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Apply aeroelastic concepts of divergence, flutter, lift and roll effectiveness, aileron reversal, and mode coalescence.
2. Derive static and dynamic aeroelastic equations of motion.
3. Demonstrate ability to formulate, model, and analyze an aeroelastic system.
4. Solve problems with a spline between structural and aerodynamic models.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy:

As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Apply aeroelastic concepts of divergence, flutter, lift and roll effectiveness, aileron reversal, and mode coalescence.	✓											
2.Derive static and dynamic aeroelastic equations of motion.		✓										
3.Demonstrate ability to formulate, model, and analyze an aeroelastic system.			✓									
4.Solve problems with a spline between structural and aerodynamic models.				✓								

Text and Ref Books:

1. J.R. Wright and J.E. Cooper, "Introduction to Aircraft Aeroelasticity and Loads", Wiley, 2007
2. Clark, Robert “A modern course in aeroelasticity” 4th ed.
3. Timoshenko, Stephen. Vibration problems in engineering. 2nd ed.
4. Y.C. Fung, "An introduction to the theory of aeroelasticity", Dover Publications Inc., New-York, 1955

Course Title: Theory of Plates and Shells

Course Code: AEAS 6141

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The course includes strong coverage of fundamentals so that students can better understand the mechanics of plates and shells.

Course Contents:

Theory of surfaces, Classical Membrane, Plate and Shell Theories., Energy Formulations, Consistent derivation of boundary conditions and edge effects, Vibration and instabilities in membrane, plates and shells, Numerical approximations such as the Finite Element method. Kirchhoff Hypotheses, fundamental equations of the classical plate theory, symmetrical bending of circular plates, bending of rectangular plates, Navier's solution and Levy's method for rectangular places, special and approximate methods in theory of plates and shells, thermal stresses in plates, theory of edge effect, buckling, membrane theory of shells, finite element analysis of plate and shell structures. Free and forced vibration of single-degree-of-freedom, two-degree-of-freedom and multiple-degree-of-freedom systems, determination of natural frequencies, experimental modal analysis, and mode shapes Transient vibrations, Analytical methods to solve dynamic systems, Eigen problems, continuous systems and their modeling, damping, vibration design and control.

Objective:

1. To impart Knowledge on the analysis of different types of plates and shells under different boundary conditions.
2. To impart knowledge on the behavior of plates and shell elements, their places of utility and of course the design procedure of such elements in practical applications.
3. To provide a knowledge of the fundamentals of theory of shells and folded plates

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Have a deep understanding the theory, concepts, principles and governing equations of the theory of shells and plates
2. Understand the Simple bending of Plates and Different Boundary Conditions for plates.
3. Analyze circular plates subjected to different kinds of loads.
4. Possess the contemporary analytical, experimental and computational tools needed to solve the idealised problem

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy:

As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Have a deep understanding the theory, concepts, principles and governing equations of the theory of shells and plates	✓											
2.Understand the Simple bending of Plates and Different Boundary Conditions for plates.	✓											
3.Analyze circular plates subjected to different kinds of loads.		✓										
4.Possess the contemporary analytical, experimental and computational tools needed to solve the idealised problem					✓							

Text and Ref Books:

1. Analysis of plates by T.K.Varadan and K.Bhaskar , Narosa Publishing House, 1999.
2. “Stresses in Shells” by Flugge. Blaisdell Publishing Co, 1966
3. Ugural, A. C. Stresses in Plates and Shells. 2nd ed. New York, NY: McGraw-Hill, 1998.

Course Title: **Thin walled structures**

Level: Post graduation program

Course Code: AEAS 6142

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: Considering structural designs and analysis of high technology structures.

Course Synopsis: Solid mechanics to analysis of high-technology structures. Structural design considerations. Review of three-dimensional elasticity theory; stress, strain, anisotropic materials, and heating effects. Two-dimensional plane stress and plane strain problems. Torsion theory for arbitrary sections. Bending of unsymmetrical section and mixed material beams. Bending, shear, and torsion of thin-wall shell beams. Buckling of columns and stability phenomena. Introduction to structural dynamics. Exercises in the design of general and aerospace structures.

Course Outcomes (CO):

Upon completion of the course, the students will be able to:

1. Explain the concepts and principles, and perform calculations, relative to the strength and stability of structures and mechanical components;
2. Evaluate the characteristics and calculate the magnitude of combined stresses in individual members and complete structures;
3. Analyze various situations involving structural members subjected to combined loads.

Teaching-learning strategy: Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by instructor.

Linkage of CO with Assessment Methods& their Weights: As convenient by instructor

Minimum attendance: 75% class attendance is mandatory for a student in order to appear at the final examination.

Mapping of Course Outcomes and Program Outcomes:

Course Outcome (CO) of the Course	**Program Outcomes* (Appendix-1)**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Explain the concepts and principles, and perform calculations,	√											

relative to the strength and stability of structures and mechanical components.												
2. Evaluate the characteristics and calculate the magnitude of combined stresses in individual members and complete structures.		√										
3. Analyze various situations involving structural members subjected to combined stresses.		√										

Text and Ref Books:

1. Strength of Materials – James M. Gere & Barry Goodno.
2. Strength of Materials (4th edition) – Andrew Pytel, Ferdinand L. Singer.
3. Strength of materials (4th edition) -William Nash; Mcgraw-hill International Editions, Schaum‘s Outline Series.
4. Strength of Materials – Beer and John Stone.

Grading System: As per the approved grading scale of MIST

Course Title: **Fracture Mechanics**

Course Code: AEAS 6143

Level: **Post Graduation Program**

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: The foundation of understanding and working for future generation of wireless systems

Course Synopsis:

Basic concepts, Toughness, elastic & plastic fracture mechanics, Fatigue, creep and Impact fracture behavior, fracture mechanism in metals and no metals, crack propagation, thermal fatigue. Investigation of linear elastic and elastic-plastic fracture mechanics. Topics include microstructural effects on fracture in metals, ceramics, polymers, thin films, biological materials and composites, toughening mechanisms, crack growth resistance and creep fracture. Also covered: interface fracture mechanics, fatigue damage and dislocation substructures in single crystals, stress- and strain-life approach to fatigue, fatigue crack growth models and mechanisms, variable amplitude fatigue, corrosion fatigue and case studies of fracture and fatigue in structural, bio-implant, and microelectronic components.

Course Outcomes (CO):

Upon completion of the course, the students will be able to:

1. Explain the concepts and principles, and perform calculations, relative to the strength and stability of structures and mechanical components;
2. Evaluate the characteristics and calculate the magnitude of combined stresses in individual members and complete structures;
3. Analyze various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress.
4. Evaluate stresses & strains for structural elements
5. Evaluate the deflection at any point on a beam subjected to a combination of loads.

Teaching-learning and

Assessment Strategy: Lectures, class performances, assignments, class tests, final exam.

Linkage of CO with Assessment Methods& their Weights:

CO	Assessment Method	(%)
	Class Assessment	
	Class Participation	05
	Class Attendance	05
1 – 4	Class Tests and Assignment	20
	Exam	
1 – 4	Final exam	70

Mapping of Course Outcomes and Program Outcomes:

Course Outcome (CO) of the Course	Program Outcomes* (Appendix-1)											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Explain the concepts and principles, and perform calculations, relative to the strength and stability of structures and mechanical components.	√											
2. Evaluate the characteristics and calculate the magnitude of combined stresses in individual members and complete structures.		√										
3. Analyze various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress.		√										
4. Evaluate stresses & strains for structural elements		√										
5. Evaluate the deflection at any point on a beam subjected to a combination of loads.		√										

Text and Ref Books:

5. Strength of Materials – James M. Gere & Barry Goodno.
6. Strength of Materials (4^{th} edition) – Andrew Pytel, Ferdinand L. Singer.
7. Strength of materials (4^{th} edition) -William Nash; Mcgraw-hill International Editions, Schaum's Outline Series.
8. Strength of Materials – Beer and John Stone.

DIVISION OF PROPULSION AND ENGINE SYSTEMS

Course Title: Gas Turbine Theory and Performance

Course Code: AEAS 6151

Level : Post-graduation program

Credit Hour: 3

Contact Hour:3

Rationale:

To analyse the gas turbine theory, how it works and design based on temperature and pressure.

Objective:

1. To know about gas turbine types and applications effect of design pressure ratio and turbine temperature.
2. To learn about basic cycle, compounding, intercooling, reheating, heat exchange, bypass and fan cycles. Performance.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Understand the design point performance of turbojet and turbo shaft cycles .
2. Apply the knowledge to design such machines like Jet engine, gas turbine engine.
3. Evaluate the design requirement of gas turbine based omn effects of heat transfer on transient performance.
4. Analyze different methoes like Method of Continuity of Mass Flow (CMF) and method of Intercomponent Volumes (ICV).

Course Content :

Gas Turbine Types and Applications Effect of design pressure ratio and turbine temperature on the basic gas turbine cycle; Modifications of the basic cycle, compounding, intercooling, reheating, heat exchange, bypass and fan cycles. Performance: Design point performance of turbojet and turbo shaft cycles, effect of bypass ratio; Off design performance, effect of ambient temperature, altitude, throttle setting and flight speed; Non-dimensional representation; Gas turbine simulation; Effects of

bleeds and power offtakes; Compressor turbine matching. Gas Turbine Transient Performance: Accelerations, decelerations, effects on surge margin; Transients of single shaft and multi-shaft engines; Transient performance simulation; Method of Continuity of Mass Flow (CMF) and method of Intercomponent Volumes (ICV); Effects of heat transfer on transient performance. Gas turbine component matching. Variable Geometry: Surge alleviation, performance improvements, steady state and transient performance. Variable Cycle Aircraft Engines: Requirement, effects on compressor operating lines, compressor variable geometry, turbine variable geometry.

Teaching-learning :

Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy:

As convenient by instructor

Mapping of course LO and Program Outcome:

Learning Outcome of this course	Program Outcome											
	1	2	3	4	5	6	7	8	9	10	11	12
Understand the design point performance of turbojet and turbo shaft cycles .	√											
Apply the knowledge to design such machines like Jet engine, gas turbine engine.		√										
Evaluate the design requirement of gas turbine based omn effects of					√							

heat transfer on transient performance.												
Analyze different methoes like Method of Continuity of Mass Flow (CMF) and method of Intercomponent Volumes (ICV).									√			

Reference Book:

1. Aircraft Gas Turbine Engine Technology by Irwin E. Treager
2. Aircraft Gas Turbine by Chester Warren Smith
3. Gas turbine engineering handbook by Meherwan Boyce

Course Title: Propulsion Systems Performance and Integration

Course Code: AEAS 6152

Level : Post-graduation program

Credit Hour: 3

Contact Hour:3

Rationale:

To analysis and understand the aircraft propulsion system and the performance of the aitcraft.

Objective:

1. Analyse and assess aircraft performance from a propulsion integration perspective
2. Compare and differentiate engine installation characteristics
3. Assess aspects of component performance and system performance integration

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Understand the theories relating propulsion system.
2. Apply the knowledge to design such machines like Jet engine, Intake and Exhaust System.
3. Evaluate the design requirement of various engineering machines.
4. Analyze of design parameters of various engineering machines.

Course Content :

The course is divided into two major components: Component Performance and System Performance and Integration, Component Performance: Three main topics are dealt with in this section: Aircraft Performance, Jet Engine Performance, Intakes and Exhaust Systems. Aircraft Performance: Details with the major topics of flight and aerodynamics, such as lift, drag, range, performance and a section on the design of aircraft for different Purposes. Jet Engine Performance: Focuses mainly on the off-design performance of jet engines. Engine behaviour at different altitudes, flight speeds, ambient conditions and throttle settings are described. This topic features a presentation on the design of engines for various types of aircraft; Intakes and Exhaust Systems: Outlines the major design features and operation of the components for subsonic and supersonic aircraft applications. System Performance and Integration: This portion of the course starts with the analysis of fundamental aerodynamics of unducted and ducted bodies; This is followed by the development, via the formal definitions of thrust and drag and the concept of stream-tube momentum force, of the relationship between the net propulsive force of the power plant, engine thrust and nacelle forces; Alternative performance accounting relationships are developed for various choices of thrust interface using force, drag and the hybrid force/drag method; These are employed to illustrate the interplay between component forces; The treatment addresses the long

and short-cowl podded nacelles, appropriate to civil engine installations, on- and off-wing; and the highly integrated installations encountered in military aircraft.

Teaching-learning :

Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy:

As convenient by instructor

Mapping of course LO and Program Outcome:

Learning Outcome of this course	Program Outcome											
	1	2	3	4	5	6	7	8	9	10	11	12
Understand the theories relating propulsion system.	√	√										
Apply the knowledge to design such machines like Jet engine, Intake and Exhaust System.		√									√	
Evaluate the design requirement of various engineering machines.				√								
Analyze of design parameters of various engineering machines					√							

Reference Book:

1. Advanced Methods for Propulsion System Integration by A Seitz

Course Title: Jet Engine Control

Course Code: AEAS 6153

Level : Post-graduation program

Credit Hour: 3

Contact Hour: 3

Rationale:

The course aims to give an introduction to aircraft engine control issues and systems.

Objective:

1. Explain the Compressor Performance of jet engines.
2. Sketch the diagram of processes involved in Axial Turbine Performance.
3. Introduction to Engine Control Systems.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. The requirements to stable Electronic Engine Control.
2. The prospects of upgrading the combustor working process in Hydromechanical Fuel Metering.
3. Further improvement in combustors should be directed to Engine Fuel Handling Systems.

Course Content :

General principles of open loop and closed loop control systems; Advantages and effects of closed loop control; Hardware in Loop Systems (HILS), Software for control laws – FADEC. Data acquisition systems, Mathematical modeling: Transfer functions; Block Diagram and signal flow graph; Time domain analysis; Frequency Domain Analysis; Stability criteria.Simple designs of compensators; Introduction to state space analysis, Types of system and their relationship with the engine, Fuel Systems: Variation of fuel requirements with operating condition. Fundamental types of control and methods of metering. Effect of burner limitations on the fuel system. Pumps. Scheduling systems (e.g. simple flow control, proportional flow control), Over-ride controls on speed, temperature, acceleration etc. Governor systems (e.g. combined acceleration and speed control, electric), advantages and disadvantages.

Teaching-learning :

Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy: As convenient by instructor

Mapping of course LO and Program Outcome:

Learning Outcome of this course	Program Outcome											
	1	2	3	4	5	6	7	8	9	10	11	12
1. The requirements to stable Electronic Engine Control.	√											
2.The prospects of upgrading the combustor working process in Hydromechanical Fuel Metering.		√										
3.Further improvement in combustors should be directed to Engine Fuel Handling Systems.				√								

Reference book:

1. Gas Turbine theory by Cohen and Roger.
2. David S. (1997). *Vikings at Waterloo: Wartime Work on the Whittle Jet Engine by the Rover Company*. Rolls-Royce Heritage Trust

Course Title: Blade Cooling

Course Code: AEAS 6154

Level : Post-graduation program

Credit Hour: 3

Contact Hour:3

Rationale:

Rotating machinery is employed today in a wide variety of industrial applications, including the oil, power and process industries. With the continuing expansion of the applications of rotating machinery, qualified personnel are required by increasingly large numbers of users.

Objective:

1. To familiarise Course Members with compressor and turbine aerodynamic design and performance by instruction, investigation and example.
2. To introduce course members to the technology of gas turbine blade cooling through analytical and practical approaches of heat transfer principles, convection cooling, impingement film transpiration cooling and liquid cooling.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Identify and analyse the design and performance characteristics of turbomachinery components;
2. For given inlet conditions and requirements, determine the aerodynamic performance characteristics of a turbomachine and comment on the feasibility of the design;
3. Differentiate the design choices for axial compressors and turbines;
4. Construct an assessment of the aspects which affect the design and performance of axial turbomachines;
5. Construct formulations and critical evaluations of underpinning turbo-machinery theories;

.

Course Content :

Review of heat transfer principles and physical significance of non-dimensional groupings, Conditions around blades, boundary layers, external heat transfer coefficient distribution, effect of turbulence, Root cooled blades and NGVs: analytical and numerical methods of determining span wise temperature distribution, Fibre strengthened and nickel base alloys, Need for high turbine entry temperature: effect on engine performance, Development of materials, manufacturing processes and cooling systems.

Teaching-learning :

Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy:

As convenient by instructor

Mapping of course LO and Program Outcome:

Learning Outcome of this course	Program Outcome											
	1	2	3	4	5	6	7	8	9	10	11	12
Identify and analyse the design and performance characteristics of turbomachinery components;	√											
For given inlet conditions and requirements, determine the aerodynamic performance characteristics of a turbomachine and comment on the feasibility of the design;		√										
Differentiate the design choices for axial compressors and turbines;				√							√	
Construct an assessment of the aspects which affect the design and performance of axial turbomachines;					√							
Construct formulations and critical						√						

evaluations of underpinning turbo-machinery theories;												

Reference Book:

1. Turbine Blade Tip Film Cooling Measurements Paperback – 1992
by Dean A. Ward (Author)
2. Gas Turbine Heat Transfer and Cooling Technology
2nd Edition
Je-Chin Han, Sandip Dutta, Srinath Ekkadz

Course Title: Combustors

Course Code: AEAS 6155

Level : Post-graduation program

Credit Hour: 3

Contact Hour:3

Rationale:

In a modern gas turbine unit (GTU), the combustor is the most responsible and heat loaded component defining reliability, efficiency and ecological friendliness of the unit as a whole.

Objective:

1. Explain the classification of external and internal combustion engines.
2. Sketch the diagram of processes involved in spark ignition and compression ignition.
3. Apply mathematical equations and solve the problems that are related to engine's criterion and comparison

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. The requirements to stable firing range, complete fuel burnup, turbine inlet temperature field non-uniformity, pressure drop, emissions of harmful substances are given which are necessary to ensure reliable and economic combustor operation.
2. The prospects of upgrading the combustor working process are considered and the lowNOx combustors firing lean homogeneous mixtures along with the long-term operational problems are reviewed.
3. Further improvement in combustors should be directed to increase the pre-mixing efficiency and to provide for stable combustion when gaseous and liquid fuels are fired. Catalytic combustors are among the most promising trends in this field. M

Course Content :

The course is divided into two major components: Component Performance and System Performance and Integration, Component Performance: Three main topics are dealt with in this section: Aircraft Performance, Jet Engine Performance, Intakes and Exhaust Systems. Aircraft Performance: Details with the major topics of flight and aerodynamics, such as lift, drag, range, performance and a section on the design of aircraft for different Purposes. Jet Engine Performance: Focuses mainly on the off-design performance of jet engines. Engine behaviour at different altitudes, flight speeds, ambient conditions and throttle settings are described. This topic features a

presentation on the design of engines for various types of aircraft; Intakes and Exhaust Systems: Outlines the major design features and operation of the components for subsonic and supersonic aircraft applications. System Performance and Integration: This portion of the course starts with the analysis of fundamental aerodynamics of unducted and ducted bodies; This is followed by the development, via the formal definitions of thrust and drag and the concept of stream-tube momentum force, of the relationship between the net propulsive force of the power plant, engine thrust and nacelle forces; Alternative performance accounting relationships are developed for various choices of thrust interface using force, drag and the hybrid force/drag method; These are employed to illustrate the interplay between component forces; The treatment addresses the long and short-cowl podded nacelles, appropriate to civil engine installations, on- and off-wing; and the highly integrated installations encountered in military aircraft.

Teaching-learning :

Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy:

As convenient by instructor

Mapping of course LO and Program Outcome:

Learning Outcome of this course	Program Outcome											
	1	2	3	4	5	6	7	8	9	10	11	12
The requirements to stable firing range, complete fuel burnup, turbine inlet temperature field non-	√				√							

uniformity, pressure drop, emissions of harmful substances are given which are necessary to ensure reliable and economic combustor operation.												
The prospects of upgrading the combustor working process are considered and the lowNOx combustors firing lean homogeneous mixtures along with the long-term operational problems are reviewed.		√										
Further improvement in combustors should be directed to increase the pre-mixing efficiency and to provide for stable combustion when gaseous and liquid fuels are fired. Catalytic combustors are among the most promising trends in this field. M				√								

Reference book:

1. Gas Turbine theory by Cohen and Roger

Course Title: Engine Systems

Course Code: AEAS 6156

Level : Post-graduation program

Credit Hour: 3

Contact Hour:3

Rationale:

To analysis and understand the aircraft propulsion system and the performance of the aitcraft.

Objective:

1. Effectively communicate technical data across different functional areas to ensure timely information sharing.

2. Establish analysis task categories and corresponding standard analysis procedures to ensure quality and consistency.

3. Develop advanced data processing templates to maximize efficiency.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Identify the function of each engine sub-system and how they relate with each other.
2. Identify individual components on various engines.
3. Explain the pros and cons of different engine fuel systems and their applications.
4. Efficiently navigate and use a variety of original equipment manufacturer (OEM)

Course Content :

Intake systems for aero engines and industrial gas turbines; anti-icing systems for aeroengines and industrial gas turbines; start systems for aeroengines and industrial gas turbines; start sequences; Compressor bleed and variable guide vanes; variable geometry nozzle guide vanes; gas path sealing of aero gas turbines; noise control of gas turbines; air filtration for industrial gas turbines; Air systems: requirements, methods of cooling, pressure balancing of end loads, sealing, cooling and

applications. Fuel System and components; Mechanical, hydro mechanical and digital control systems. Lubricants and their properties; Lubrication systems Regimes of lubrication: including hydrodynamic lubrication, hydrostatic lubrication, elasto-hydrodynamic lubrication, plain bearings, rolling element bearings, gears, additives. Nature and properties of rubbing materials lubricant and grease composition; lubricant specification. Types and mechanisms of tribological damage: Ignition system; Requirements and problems of altitude relight. Types of system -booster coils, high frequency, high energy and their applications.Starting Systems; Electrical systems - low and high voltage, turbine systems- cartridge, iso-propyl nitrate, fuel-air, gas turbine, low pressure air and hydraulic systems and their applications. Engine control systems; Nozzle control systems and specification; derivation and approximations to Reynolds' equation. Full authority and other electronic control systems

Teaching-learning :

Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy:

As convenient by instructor

Mapping of course LO and Program Outcome:

Course Outcome (CO) of the Course	**Program Outcomes* (Appendix-1)**											
	1	2	3	4	5	6	7	8	9	10	11	12

Identify the function of each engine sub-system and how they relate with each other.					√							
Identify individual components on various engines.		√										
Explain the pros and cons of different engine fuel systems and their applications.	√											
Efficiently navigate and use a variety of original equipment manufacturer (OEM)	√											

Reference Book:

1. *Automotive engineering fundamentals* / Richard Stone and Jeffrey K. Ball
2. *A Text Book of Automobile Engineering*. Front Cover · R. K. Rajput.

Course Title: Aerospace Rotating Equipment Selection

Course Code: AEAS 6167

Level : Post-graduation program

Credit Hour: 3

Contact Hour:3

Rationale:

To familiarise the course member with various operations of gas turbines and other driven rotating machines.

Objective:

1. Differentiate the operational regimes and requirements related to different gas turbine applications.
2. Evaluate gas turbine performance using machine data from actual operations.
3. Assess engine performance deterioration, as well as propose improved approaches in enhancing performance during operation.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Identify components and parameters related to steam turbine theory, performance and operation.
2. Differentiate and assess the applications of steam turbines.
3. Calculate diesel engine performance parameters, differentiate between 2-stroke and 4-stroke engines and differentiate operational requirements for these applications.
4. Differentiate and assess the applications of diesel engines for heat and power.
5. Evaluate the approaches to reducing and controlling harmful exhaust emissions in diesel engines.

Course Content :

Electric Motors And Generators - An overview of the important electrical features of power generation. This will provide an understanding of the design features of synchronous and asynchronous machines often driven by gas turbines; Pumps and Pumping Systems - Participants will be introduced to the basic principles of pumps including Euler equation, relation of pump geometry to design performance, cavitation, viscosity effects, part load behaviour, gas liquid pumping, etc. In particular, attention will be given to cavitation, gas-liquid and other multi-phase problems, and to the drive systems used, particularly gas turbine drives; Gas Turbines and Selection - An overview of their principles and modes of operation, and, selection criteria; Gas Compressors - An insight will be given into the theory, selection, operating range and installation of the various types of compressor. Some common installation problems will be discussed and analyzed. Basic turbomachinery Concepts – Energy transfer in turbomachines, non-dimensional parameters, flow in cascades and isolated airfoils, principles of turbomachinery design, three dimensional flows, definitions of efficiency, case studies.

Teaching-learning :

Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy:

As convenient by instructor

Mapping of course LO and Program Outcome:

Learning Outcome of this course	Program Outcome											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Identify components and parameters related to steam turbine theory, performance and operation.	√				√							
2. Differentiate and assess the applications of steam turbines.		√										
3. Calculate diesel engine				√								

performance parameters, differentiate between 2-stroke and 4-stroke engines and differentiate operational requirements for these applications.												
4. Differentiate and assess the applications of diesel engines for heat and power.						√						
5. Evaluate the approaches to reducing and controlling harmful exhaust emissions in diesel engines.									√			

Reference Book:

1. Introduction to Aerospace Engineering with a Flight Test Perspective
Stephen Corda
2. Aerodynamics for Engineers, 6th Edition
Russell M. Cummings

Course Title: Mechanical Design of Turbo-Machinery

Course Code: AEAS 6158

Level : Post-graduation program

Credit Hour: 3

Contact Hour:3

Rationale:

This course will provide both design and application engineers with an understanding of the mechanical aspects of turbomachinery design. Techniques by which a design can be optimized are emphasized, and process for analytical validation of new designs and developing new components for existing machines is described from preliminary through detailed design.

Objective:

1. Calculate the main dimensions of hydro- and gas-turbines.
2. Evaluate which turbine to be used in a Hydro Power Plant or a Gas Power Plant
3. Evaluate which pump or compressor to be used in a process-, gas- or a fluid-system.

Learning Outcomes (LO):

1. Cavitation in Francis turbines
2. Surge and chocking in compressors and gas-turbines.
3. The course gives the student insight about:
4. Basic design of Wind turbines, Reversible Pumpturbines, multi-phase pumps and wet gas compressors.
5. Main components in a Hydro Power Plant and Gas Power Plant.

Course Content :

The course is divided into two major components: Component Performance and System Performance and Integration, Component Performance: Three main topics are dealt with in this section: Aircraft Performance, Jet Engine Performance, Intakes and Exhaust Systems. Aircraft Performance: Details with the major topics of flight and aerodynamics, such as lift, drag, range, performance and a section on the design of aircraft for different Purposes. Jet Engine Performance: Focuses mainly on the off-design performance of jet engines. Engine behaviour at different altitudes, flight speeds, ambient conditions and throttle settings are described. This topic features a presentation on the design of engines for various types of aircraft; Intakes and Exhaust Systems: Outlines the major design features and operation of the components for subsonic and supersonic aircraft applications. System Performance and Integration: This portion of the course starts with the analysis of fundamental aerodynamics of unducted and ducted bodies; This is followed by the development, via the formal definitions of thrust and drag and the concept of stream-tube momentum force, of the relationship between the net propulsive force of the power plant, engine thrust and nacelle forces; Alternative performance accounting relationships are developed for various choices of thrust interface using force, drag and the hybrid force/drag method; These are employed to illustrate the interplay between component forces; The treatment addresses the long and short-cowl podded nacelles, appropriate to civil engine installations, on- and off-wing; and the highly integrated installations encountered in military aircraft.

Teaching-learning :

Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy:

As convenient by instructor

Mapping of course LO and Program Outcome:

Learning Outcome of this course	Program Outcome											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Cavitation in Francis turbines	√											
2. Surge and chocking in compressors and gas-turbines.		√										
3. The course gives the student insight about:				√								
4. Basic design of Wind turbines, Reversible Pumpturbines, multi-phase pumps and wet gas compressors.					√						√	
5. Main components in a Hydro Power Plant and Gas Power Plant.						√						

Reference Book:

1. *Turbomachinery Design* and Theory Rama S. R. Gorla
2. *Turbo-Machinery* Dynamics by A. S. Rangwala

Course Title: Gas Turbine Simulation and Diagnostics

Course Code: AEAS 6159

Level : Post-graduation program

Credit Hour: 3

Contact Hour: 3

Rationale:

The gas turbine engine is a very complex device. Its high power to weight ratio has made it the propulsion system of choice in aircraft applications. It is also used extensively in the oil, gas, power and process industries.

Objective:

1. An understanding of the basic principles underpinning its design, operation and behaviour is essential for all engineers involved in the development, production, procurement and use of gas turbines.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. The course provides delegates with an understanding of how different types of gas turbine produce useful power and how their output is influenced by a very wide range of operating conditions.
2. The three major categories of gas turbine applications are covered, civil aviation, military aviation and mechanical power applications.
3. When completing the course the delegate should be able to understand the influence of mission on the choice of gas turbine cycle and how gas turbines behave in a very wide range of operating conditions.

Course Content :

Basic theory and calculations for components (intake, nozzle, duct, compressor, turbine, combustor, intercooler and recuperator); Design-point performance calculations; Off-design performance calculations and iteration techniques; Gas Turbine Performance Code: TURBOMATCH; Description of gas turbine performance degradation and faults; Description of most commonly used

gas turbine condition monitoring techniques; Linear and non-linear GPA, and other performance analysis based diagnostic techniques; Gas path sensor fault and diagnostics; Gas path measurement and uncertainty; Gas turbine gas path diagnostics code; Practical content involves the use of the small gas turbine engine test facility**.** Laboratory performance test; Simulation of the engine performance using TURBOMATCH; Simulation of the deteriorated performance of the engine; Fault diagnosis using linear Gas path Analysis (GPA) by hand calculation; Fault diagnosis by non-linear GPA using appropriate

Teaching-learning :

Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy:

As convenient by instructor

Mapping of course LO and Program Outcome:

Learning Outcome of this course	**Program Outcome**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. The course provides delegates with an understanding of how different types of gas turbine produce useful power and how their output is influenced by a very wide range of operating conditions.	√											
2. The three major categories of gas turbine applications are covered, civil aviation, military aviation and mechanical power applications.		√										
3. When completing the course the				√								

delegate should be able to understand the influence of mission on the choice of gas turbine cycle and how gas turbines behave in a very wide range of operating conditions.												

Reference Book:

1. Gas Turbine Diagnostics: Signal Processing and Fault Isolation 1st Editionby Ranjan Ganguli]
2. Fault *Diagnosis* of *Gas Turbine* Engines by Z Abbasfard

Course Title: Gas Turbine Applications

Course Code: AEAS 6160

Level : Post-graduation program

Credit Hour: 3

Contact Hour:3

Rationale:

The course will cover the design, installaon, operaon and maintenance of these machines by highlighng characteriscs features, efficiencies, reliability and maintenance implicaons. Upon compleon of this course, parcipants will gain a complete and up-to-date overview of the Gas Turbine Technology.

Objective:

1. Be able to idenfy GT Problems and how to prevent them
2. Be able to do basic calculaons
3. Be able to use equipment on maintenance

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Understand the major aspects of GT
2. Understand the importance of solving the vibraon problem Plus more knowledge and understanding on;
3. Mechanical design principal

Course Content :

General considerations in selecting land and marine gas turbines: Relationship of application to design; Specific power and efficiency considerations; Emergency standby, peaking and continuous duty operation; Design layouts, implications of single and multi-spool systems; Choices for power generation and compressor, pump or propeller drives; Engine ratings, types of usage and life implications; Introduction to availability and reliability issues; Emissions, fuel types and power systems layouts. Civil aero gas turbine design and strategy consideration: Historical background, nature of industry and market size; Technology drivers, core excess power, cycle temperatures, materials and cooling; Component efficiencies, cycle and propulsion efficiencies; Overall efficiency trends, design implications and unusual solutions; Growth, risk management and

globalization of industry. Availability, reliability, engine health monitoring and risk management: Availability and reliability concerns for single and multiple engine configurations; Engine health monitoring, linear and non-linear gas path analysis; Role of instrumentation, life usage and risk assessment; Reliability and availability of components and multi-engine installations. Use of heavy, blended, contaminated or crude fuels: Introduction, type and range of fuels considered, fuel specifications; Fuel properties and implications for fuel system and combustor design; hot section corrosion considerations, additives, fouling, cleaning and rating considerations; Implications on choice of engine and economic operation. Coal and solid fuels: Relevance of coal as a fuel for gas turbine utilization; Routes to coal utilization, gasification, coal derived liquid fuels; Combustion of solid coal, atmospheric and pressurized fluid bed combustion; Current developments, technology and commercial risks.

Teaching-learning : Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy:

As convenient by instructor

Mapping of course LO and Program Outcome:

Learning Outcome of this course	Program Outcome											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Understand the major aspects of GT	√											
2. Understand the importance of solving the vibraon problem Plus more knowledge and understanding on;		√										
3. Mechanical design principal				√								

Reference Book:

1. **Gas Turbine Engineering Handbook** - 4th Edition

DIVISION OF AEROSPACE MATERIALS

Course Title: Advanced Materials in Engineering

Course Code: AEAS 6171

Level : Post-graduation program

Credit Hour: 3

Contact Hour:3

Rationale:

The relationship between the properties, structure and processes of engineering materials is discussed. Emphasis on the fundamentals of selecting materials based on engineering design criteria. Also offered as ENGR 170.

Objective:

1. Conceptually explain the classification schemes that are used to categorize engineering materials.
2. Explain the differences in the mechanical behavior of engineering materials based upon bond type, structure, composition, and processing.
3. Describe the basic structures and repeat units for common thermoplastics and relate the distribution of molecular weights, degree of polymerization, percent crystallinity, and glass transition temperature to properties in service.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Describe how and why defects (point, line and interfacial) in materials greatly affect engineering properties and limit their use in service
2. Calculate engineering stress, strain and the elastic modulus from data and for basic engineering applications.
3. Describe why each of the fundamental mechanical engineering properties of materials covered in the course (stress, strain, elastic constant, creep, fatigue, wear, hardness, Poisson's ratio, toughness, ductility, flexural strength, impact strength, elongation) are important in engineering design.
4. Select the appropriate engineering materials and size basic parts, including the use of appropriate safety factors and cost, for specific engineering applications using mechanical properties such as: yield strength, tensile strength, ductility or elongation, impact strength, toughness, Poisson's ratio, flexural strength, hardness, fatigue life, endurance limit, wear, and creep

Course Content :

Introduction to materials: Atomic structure, crystal structure, imperfections, diffusion, mechanical properties, dislocations and strengthening mechanisms, phase diagrams, phase transformations, solidification, corrosion; Basic and alloy steels, tensile behaviour of metals, work and precipitation hardening, recovery and recrystallization; Structural steels - C-Mn ferrite-pearlite structural steels, specifications and influence of composition, heat treatment and microstructure on mechanical properties. Fracture, weldability and the influence of welding on mechanical properties; Corrosion Resistant Materials - Stainless steels - austenitic, ferritic, martensitic and duplex stainless steels - compositions, microstructures, properties; Welding and joining processes, weld metal, heat affected zones and weld cracking; Non-metallic Materials - Polymers and composites manufacturing issues, physical properties and mechanical behavior; Structure and properties and applications of ceramics; Principles underlying electrical and magnetic properties of materials.

Teaching-learning :

Lectures, Research papers review, Case study of ethical issues in different research lab, effective data management producer, class performances, assignments, class tests etc

Assessment Strategy:

As convenient by instructor

Mapping of course LO and Program Outcome:

Learning Outcome of this course	Program Outcome											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Describe how and why defects (point, line and interfacial) in materials greatly affect engineering properties and limit their use in service	√											
2. Calculate engineering stress, strain and the elastic modulus from data and for basic engineering applications.		√										
3. Describe why each of the fundamental mechanical engineering properties of materials covered in the course (stress, strain, elastic constant, creep, fatigue, wear, hardness, Poisson's ratio, toughness, ductility, flexural strength, impact strength, elongation) are important in engineering design.						√						
4. Select the appropriate engineering materials and size basic parts, including the use of appropriate safety factors and cost, for specific engineering				√								

applications using mechanical properties such as: yield strength, tensile strength, ductility or elongation, impact strength, toughness, Poisson's ratio, flexural strength, hardness, fatigue life, endurance limit, wear, and creep												

Reference Book:

1. Advanced Materials Science and Engineering of Carbon b y Michio Inagaki Feiyu Kang Masahiro Toyoda Hidetaka Konno
2. Materials Science and Engineering by William Callister

Course Title: Advanced Strength of Materials

Course Code: AE 6172

Pre-requisite: Engineering Materials, Solid Mechanics.

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to describe the Structure of solids, Band theory of solids, Significance of structure property relationship; Imperfections in solids; Diffusion phenomenon, Applications of diffusion; Principles of solidification, Thermodynamics of solutions; Phase diagrams and phase transformations, Basic definitions and determination and applications; Heat treatment; Ceramic materials, Classification, Crystal structure, Properties, Characterization and applications.

Course Contents:

Various responses exhibited by solid engineering materials when subjected to mechanical and thermal loadings; an introduction to the physical mechanisms associated with design-limiting behavior of engineering materials, especially stiffness, strength, toughness, and durability; an understanding of basic mechanical properties of engineering materials, testing procedures used to quantify these properties, and ways in which these properties characterize material response; quantitative skills to deal with materials-limiting problems in engineering design; and a basis for materials selection in mechanical design.

Objective:

1. To determine the Mechanical behavior of the body by determining the stresses, strains produced by the application of load.
2. To apply the fundamentals of simple stresses and strains.
3. To facilitate the concept of bending and its theoretical analysis.
4. To apply fundamental concepts related to deformation, moment of inertia, load carrying capacity, shear forces, bending moments, torsional moments, column and struts, principal stresses and strains.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. To understand the basics of material properties, stress and strain.
2. To apply knowledge of mathematics, science, for engineering applications

3. Ability to identify, formulate, and solve engineering & real life problems
4. Ability to design and conduct experiments, as well as to analyze and interpret data
5. Ability to design a component to meet desired needs within realistic constraints of safety.

Teaching-learning Strategy: Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by the instructor.

Mapping of course LO and Program Outcome:

Learning Outcomes (LOs) of this course	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1. To understand the basics of material properties, stress and strain.	√											
2. To apply knowledge of mathematics, science, for engineering applications		√										
3. Ability to identify, formulate, and solve engineering & real life problems		√										
4. Ability to design and conduct experiments, as well as to analyze and interpret data			√									
5. Ability to design a component to meet desired needs within realistic constraints of safety.						√						

Text and Ref Books:

1. **Strength of Materials** – James M. Gere & Barry Goodno.

2. **Strength of Materials (4th edition)** – Andrew Pytel, Ferdinand L. Singer.

3. **Strength of materials (4th edition)** -William Nash; Mcgraw-hill International Editions, Schaum‘s Outline Series.

4. **Strength of Materials** – Beer and John Stone.

Course Title: Aerospace Materials Processing and Performance

Course Code: AE 6173

Pre-requisite: Engineering Materials.

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

This course teaches the fundamentals for the analysis of materials and structures in engineering with a specific focus on aircraft and space structures. The lectures are split into two parallel modules: Solid Mechanics and Materials and Structures. The Solid Mechanics module covers general material relating to the analysis of stresses, strains, deformation, and strength in solid materials and simple components. Specific topics include stress and strain tensors, elasticity, plasticity, elementary solutions of theories of elasticity and plasticity, principles of minimum potential energy, and finite element modeling. The second module, Materials and Structures is focused on the application of material and structural design to aerospace components and structures. Topics covered include composite materials and mechanics, asymmetric sections, and analysis of skinned structures.

Course Contents:

Review requirements for airframe and aero engines; Structural metals -light alloys including aluminum and magnesium, titanium; Ceramic and ceramic matrix composites; Joining issues specifically adhesively bonded joints and mechanically fastened joints; Production of structures containing both carbon fibre reinforced composite and metal (hybrids); Composite performance; Active materials (in functional materials module); Maintenance and vehicle heath monitoring.

Objective:

1. Explain the theory, concepts, principles and governing equations of solid mechanics.
2. Demonstrate the ability to deconstruct complex problems to produce effective outcomes.
3. Use analytical, experimental and computational tools needed to solve the idealized problem.
4. Explain the selection, design and stress analysis of composite materials

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Use these solutions to guide a corresponding design, manufacture, or failure analysis.
2. Demonstrate the ability to deconstruct complex problems to produce effective outcomes.
3. Analyze the stresses in simple structures as used in the aerospace industry;

4. Demonstrate the ability to independently design new solutions, principles and methods, read and understand professional articles on the subject.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by the instructor.

Mapping of course LO and Program Outcome:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Use these solutions to guide a corresponding design, manufacture, or failure analysis.		√										
2. Demonstrate the ability to deconstruct complex problems to produce effective outcomes.				√								
3. Analyze the stresses in simple structures as used in the aerospace industry;											√	
4. Demonstrate the ability to independently design new solutions, principles and methods, read and understand professional articles on the subject.			√									

Text and Ref Books:

1. **Aircraft Structures for Engineering Students**, Butterworth-Heinemann, Megson, T.H.G., 2007.
2. **Composite Materials-Science and Engineering**, Chawla, K. K. Springer, 2nd ed, 1998.
3. **Fundamentals of Aircraft Structural Analysis**, Curtis, H.D., McGraw-Hill, 2002.
4. **The Science and Engineering of Materials 3rd SI Edition**, Askeland, D.R.,Chapman and Hall 1999.
5. **Materials Science and Engineering An Introduction**, 7ed, Callister W.D., Wiley, 2007.

Course Title: Composites Manufacturing for High Performance Products

Course Code: AE 6174

Pre-requisite: Engineering Materials.

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

Composites are used in many industries today to enable high-performance products at economic advantage. These industries range from space to sports and include manufactured products for aircraft, transportation, energy, construction, sports, marine, and medical use. There are many material, economic and aesthetic advantages to using composites, but a solid knowledge of the physical properties, including the mechanics, tooling, design, inspection & repair, and manufacturing options is required for working in this medium as they are intrinsically linked.

Course Contents:

Introduction; Background to thermosetting and thermoplastic polymer matrix composites; Practical demonstrations – lab work; Overview of established manufacturing processes; Developing processes; Automation; Machining; Future process developments (including tufting, nanoparticle modified resins, hybrid materials, TTR); Assembly and cost; Applications - case studies from aerospace, automotive, marine and energy sectors; DVD demonstrations of all processing routes.

Objective:

1. Fundamentals in materials, manufacturing, mechanics, design, and repair of polymeric matrix composites
2. Advantages and disadvantages of polymeric matrix composites with respect to metals
3. Design and manufacturing of high performance composite structures.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Explain Fundamentals in materials, manufacturing, mechanics, design, and repair of polymeric matrix composites
2. Analysis basic properties of Advantages and disadvantages of polymeric matrix composites with respect to metals
3. Design and manufacturing of high performance composite structures

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by the instructor.

Mapping of course LO and Program Outcome:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Explain Fundamentals in materials, manufacturing, mechanics, design, and repair of polymeric matrix composites		√										
2. Analysis basic properties of Advantages and disadvantages of polymeric matrix composites with respect to metals					√							
3. Design and manufacturing of high performance composite structures			√									

Text and Ref Books:

1.***Hybrid and Select Metal-Matrix Composites***, Chamis CC and Lark RF, 1977.
2.***An Introduction to Composite Materials***, Hull D, 1981, (Cambridge University Press).
3.***Mechanics of Composite Materials***, Jones RM, 1975, (Scripta Books, Washington DC).
4.***Composite Materials: Engineering and Science***, Matthews FL and Rawlings RD, 1994, (Chapman & Hall, London).

Course Title: Functional Materials

Course Code: AE 6175

Pre-requisite: Engineering Materials, Composite Materials.

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

Functional materials are materials that have one or more properties that can be significantly changed in a controlled fashion by external stimuli (temperature, electric/magnetic field, etc.) and are therefore applied in a broad range of technological devices as for example in memories, displays and telecommunication.

Course Contents:

Functional materials for energy: Piezo and pyro electric, conducting, semi conducting, magnetic, thermoelectric; Nano and Micro devices for energy: Piezo harvesters, Solid oxide fuel cells, Battery and supercapacitor technologies, Thermo-electrics, PV and solar cells; Materials and devices used in aerospace: solar cells, semiconductors, adaptable thin films, sensors, actuators.

Objective:

1. Have insight in a broad range of current and future important types of functional material.
2. Show insight in some examples, which are discussed during the course, on developments of new materials with special properties and potential applicability of these in the future..
3. Relate the properties of functional materials to their structure..

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Apply crystal symmetry analysis to explain, classify, and together with tensor formulation, calculate directional dependent properties of functional materials (for example, conductivity, resistance, piezoelectricity)..

2. Explain with the help of band structure model the characteristics and the applicability of functional materials, especially regarding semiconductors..

3. Explain the principles of magnetic, optical and electric properties of materials, and can give specific examples of materials and applicability.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by the instructor.

Mapping of course LO and Program Outcome:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Apply crystal symmetry analysis to explain, classify, and together with tensor formulation, calculate directional dependent properties of functional materials (for example, conductivity, resistance, piezoelectricity)..		√										
2. Explain with the help of band structure model the characteristics and the applicability of functional materials, especially regarding semiconductors..	√											
3. Explain the principles of magnetic, optical and electric properties of materials, and can give specific examples of materials and applicability.						√						

Text and Ref Books:

1. **Functional Materials: Preparation, Processing and Applications**- A.K. Tyagi
2. **Functional Materials for Sustainable Energy Applications** - J. A. Kilner.
3. **Physics of Functional Materials**- Hasse Fredriksson and Ulla Åkerlind

Course Title: Failure of Materials and Structures

Course Code: AE 6176

Pre-requisite: Engineering Materials, Composite Materials, Solid Mechanics.

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is the emphasis moves away from alloy development and design, and focuses on the performance of structural materials in a range of engineering applications. The lectures draw on examples from applications of ceramics, steel; Al, Ti and Ni based alloys, and compares this with the performance of composites: polymer matrix, metal matrix and ceramic matrix systems. Engineering assessment of each failure problem is described and the associated micromechanical failure modes, understanding of which allows improved materials design and selection for a wide range of service environments.

Course Contents:

Overview of failure behavior of cracked bodies; crack size influence, brittle and ductile behavior; influence of material properties; cyclic loading and chemical environment; Thermodynamic criteria and energy balance- Griffith approach, modifications by Orowan; Strain energy release rate, compliance, applications to fiber composites; Linear elastic fracture mechanics (LEFM) and crack tip stress fields, stress concentration, stress intensity, plane stress and plane strain; fracture toughness in metallic materials; fracture toughness testing; calculations of critical defect sizes and failure stress; Crack tip plastic zones, the HRR field; CTOD, J; elastic- plastic failure criteria; defect assessment failure assessment diagrams; Fracture of rigid polymers and standard tests for fracture resistance of polymers; Delamination fatigue tests. Emerging CEN/ISO standards, current ESIS test procedures; Crack extension under cyclic loading; regimes of fatigue crack growth; influence of material properties and crack tip plastic zones; calculation of crack growth life and defect assessment in fatigue; crack closure and variable amplitude loading; short cracks and the limits of LEFM; software design tools for fatigue crack growth; Static loading-stress corrosion cracking; corrosion fatigue.

Objective:

1. Describe failure micromechanisms occurring for a range of service conditions
2. Relate these failure micromechanisms to optimized materials microstructures
3. Assess likely service failures for a range of service conditions

4. Analyze key factors influencing materials failure: evaluate complex materials/structural failure situations and propose appropriate engineering solutions
5. Assess fractographic images in some detail
6. Predict how a component/structure would behave under given service conditions
7. Predict the fatigue strength of a component with a complex geometry, a bolted structure and a welded structure.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Identify appropriate testing approaches to evaluate materials' service performance
2. Analyse complex service failure problems and apply the correct fracture mechanics approach
3. Propose appropriate lifing methodologies for service applications
4. Critically analyse the factors affecting component/structure performance

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by the instructor.

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Identify appropriate testing approaches to evaluate materials' service performance	√											
2. Analyze complex service failure problems and apply the correct fracture				√								

mechanics approach												
3. Propose appropriate lifing methodologies for service applications						√						
4. Critically analyses the factors affecting component/structure performance							√					

Text and Ref Books:

1. **Materials Science and Engineering, an Introduction**, William D. Callister (2002).
2. **Fatigue of Materials** - S. Suresh (1988).
3. **Metals Handbook**, volume 11 **Failure Analysis and Prevention,** volume 13.

Course Title: Surface Science and Engineering

Course Code: AE 6177

Pre-requisite: Engineering Materials, Solid Mechanics.

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is the aspects of surface engineering, to develop fundamental understanding and the role of materials to allow surface selection for mechanical contacts and their surrounding environmental conditions.

Course Contents:

Philosophy of surface engineering, general applications and requirements; Basic principles of electrochemistry and aqueous corrosion processes; Corrosion problems in the aerospace industry; General corrosion, pitting corrosion, crevice corrosion, influence of deposits and anaerobic conditions; Exfoliation corrosion; Corrosion control; High temperature oxidation and hot corrosion; Corrosion/mechanical property interactions; Friction and Wear: abrasive, erosive and sliding wear; The interaction between wear and corrosion; Analytical Techniques: X-ray diffraction, TEM, SEM and EDX, WDX analysis, surface analysis by AES, XPS and SIMS, overview of other techniques; Data interpretation and approaches to materials analysis; Surface engineering as part of a manufacturing process; Integrating coating systems into the design process; Coating manufacturing processes; Electro deposition; Flame Spraying; Plasma spray; Physical vapor deposition; Chemical vapour deposition; HIP surface treatments; Coating systems for corrosion and wear protection; Coating systems for gas turbines; New coating concepts including multi-layer structures, functionally gradient materials, intermetallic barrier coatings and thermal barrier coatings.

Objective:

1. Fundamentals of tribology and related contact mechanics.
2. Principles of coating deposition methods
3. Fundamental coating properties and their relationship.
4. Introduction to corrosion and corrosion protection.
5. Pros and cons of different approaches in surface engineering.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Search and critically review technical literature.
2. Analyze advantages and limitations of surface engineering methods

3. Compare different coating technologies from various perspectives.
4. Think, observe, communicate, evaluate information and data, analyses and solve problems.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Mapping of course LO and Program Outcome:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Search and critically review technical literature.		√										
2. Analyze advantages and limitations of surface engineering methods						√						
3. Compare different coating technologies from various perspectives.			√									
4. Think, observe, communicate, evaluate information and data, analyses and solve problems										√		

Text and Ref Books:

1. **Surface Coatings for Protection against Wear**. B.G. Mellor (ed.), (2006).
2. **Handbook of Tribology: Materials, Coatings and Surface Treatments**. B. Bhushan, B.K. Gupta (1991).
3. **Contact Mechanics**. K.L. Johnson (1996).
4. **Friction and Wear of Engineering Materia ls**. I.M. Hutchings. Tribology:
5. **Engineering Tribology**. J.A. Williams (2005).

6. **Materials Science and Engineering, an Introduction.** W.D. Callister (2003).
7. **Handbook of Surface Treatments and Coatings**. M. Cartier (2003).
8. **Engineering Tribology**. G.W. Stachowiak (2005).

Course Title: Aerospace Materials Selection

Course Code: AEAS 6178

Pre-requisite: Engineering Materials.

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

With the continued growth of the global aerospace sector and the renewed interest in space systems, there is a real need for specialist engineers with a deep understanding of aerospace materials.

This course enhances specialist skills to develop new materials for next-generation aircraft and future aerospace. You will play a major role in addressing environmental impact and sustainability with the sector.

Course Contents:

Principles of materials selection: Materials selection procedures, Check lists, Elementary stressing calculations; Choice of fabrication techniques; Case studies; Data sources; Material selection group exercise; Material selection individual exercise; Specific polymers and composites- the structure, properties, processing characteristics and applications for the commercially important polymers; General classes of polymers: commodity, engineering and specialty thermoplastics, thermosetting resins, rubbers; Variation in behavior within families of polymers: crystallinity, rubber toughened grades; reinforced and filled polymers; Specific metals, alloys- The metallurgy, properties, applications and potentialities of metals and alloys in a wide variety of engineering environments; Specific metals and alloys both for general use and for more demanding applications; Titanium, nickel and magnesium based alloy, intermetallics, steels; The design of alloys, current developments in the field of light alloys, steels, high temperature materials; Development of current aerospace aluminum alloys: precipitation hardening, effect of precipitates on mechanical properties, designation of aluminum alloys, alloys based on Al-Cu, alloys based on Al-Zn; Introduction to engineering ceramics: introduction to particulate engineering, thermodynamic and kinetic requirements for powder processing, Interparticle forces; Ceramic forming techniques, Sintering and densification, Processing related properties of ceramics: structural and functional.

Objective:

The aim of this module is to

1. Provide students with the knowledge and skills required to enable them to carry out the selection of appropriate materials for a wide range of engineering and other applications.
2. Knowledge of a range of materials properties and skills

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Use of a wide range of materials that will enable students to undertake materials selection effectively, using appropriate reference sources (books, data sheets, computer databases etc).
2. An understanding of the ranges of properties and processing characteristics exhibited by the above materials, including the variations within a single family and the differences between families of materials.
3. A systematic approach to the selection of material(s) to meet the requirements of a component design brief.
4. Appropriate selection of component manufacturing method(s) as part of the materials selection exercise.

Teaching-learning Strategy: Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by the instructor.

Mapping of course LO and Program Outcome:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Use of a wide range of materials that will enable students to undertake materials selection effectively, using appropriate reference sources (books,		√										

	data sheets, computer databases etc).											
2.	An understanding of the ranges of properties and processing characteristics exhibited by the above materials, including the variations within a single family and the differences between families of materials.				√							
3.	A systematic approach to the selection of material(s) to meet the requirements of a component design brief.		√									
4.	Appropriate selection of component manufacturing method(s) as part of the materials selection exercise.			√								

Text and Ref Books:

1. **Aircraft Structures for Engineering Students**, Megson, T.H.G.,Butterworth-Heinemann, 2007.
2. **Composite Materials-Science and Engineering**, Chawla, K. K., Springer, 2nd ed, 1998.
3. **Fundamentals of Aircraft Structural Analysis**, Curtis, H.D. McGraw-Hill, 2002.
4. **The Science and Engineering of Materials 3rd SI Edition**, Askeland, D.R. Chapman and Hall 1999.
5. **Materials Science and Engineering An Introduction**, 7ed, Callister W.D., Wiley, 2007

Course Title: Polymer Engineering

Course Code: AEAS 6179

Pre-requisite: Composite Materials.

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

Polymer fabrication processes and methods of characterization and identification of polymers are presented. Experiments in polymerization, processing, and property evaluation of polymers.

Course Contents:

Ooverview of engineering analysis and design techniques for synthetic polymers, treatment of materials properties selection, mechanical characterization, and processing in design of load-bearing and environment-compatible structures are covered.

Objective:

1. describe the viscoelastic behavior of polymers with respect to their chemical structures and molecular weights, and to construct a corresponding master curve from the experimental data, which can be used to predict the material response at different temperatures, times, and/or frequencies. develop the social awareness and responsibilities of the engineer in society.
2. Will be able to run extrusion and injection molding machines, and to collect and analyze data. This will help them to make connections between the polymer molecular weight, viscoelastic properties, and processing conditions.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Understand the relationships between polymer molecular weight, molecular weight distribution, and the properties of polymeric materials
2. Demonstrate an ability to distinguish different polymerization reactions and their mechanisms/kinetics, and learn how actual polymerization is performed in the laboratory. Students will also be able to analyze polymerization data and predict the conversion and

molecular weight, which will lead to critical thinking about how to improve the setup for better polymerization.

3. Determine polymer molecular weights and molecular weight distributions from different types of experiments. Students will learn about polymer solvent interaction and the effect of the solvents on the dimensions of the polymers in solution.
4. Improve and expand their skills in performing and analyzing the thermal and mechanical properties of polymers, and demonstrate an ability to predict how the molecular weight will affect these properties.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by the instructor.

Mapping of course LO and Program Outcome:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Understand the relationships between polymer molecular weight, molecular weight distribution, and the properties of polymeric materials	√											
2. Demonstrate an ability to distinguish different polymerization reactions and their mechanisms/kinetics, and learn how actual polymerization is performed in the laboratory. Students will also be able to analyze polymerization data and predict the conversion and molecular weight, which will lead to critical thinking about how to improve the setup for better			√									

polymerization.												
3.Determine polymer molecular weights and molecular weight distributions from different types of experiments. Students will learn about polymer solvent interaction and the effect of the solvents on the dimensions of the polymers in solution.										√		
4.Improve and expand their skills in performing and analyzing the thermal and mechanical properties of polymers, and demonstrate an ability to predict how the molecular weight will affect these properties.			√									

Text and Ref Books:

1. **Essentials of Polymer Science and Engineering**, Paul C. Painter and Michael M. Coleman, Destech Publications, Inc., 2008.

Course Title: Degradation of Materials

Course Code: AEAS 6180

Prerequisite: Engineering Materials

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The purpose of this course is to focus on the basic degradation behavior of engineering materials, Explains the principles of electrochemistry, Describe the types of corrosion. Costs of corrosion and wear, forms of corrosion, electrochemistry, corrosion thermodynamics and kinetics, high temperature oxidation, metallurgical and environmental factors, corrosion protection, coatings and inhibitors, degradation of polymers, friction and lubricants, wear mechanisms, measurement and testing, analysis and correction of corrosion and wear failures, materials selection and safety.

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Course Contents:

Damage and failure of materials and structures due to corrosion and wear, and relevant methods used to prevent such damage and failures, electrochemical fundamentals of corrosion; forms of corrosion; corrosion testing methods; corrosion control and prevention; corrosion-resistant materials; types of wear; wear mechanisms; wear-resistant materials; and control of wear through materials selection and design. The main contents include uniform, pitting, galvanic and crevice corrosion; intergranular corrosion and selective leaching; stress corrosion cracking and corrosion fatigue; high temperature oxidation and hydrogen embrittlement; corrosion testing methods and standards, corrosion control and prevention strategies and techniques; abrasive, adhesive, and erosion wear; and materials selection and design against corrosion and wear.

Objective:

1. Introduce students to corrosion and tribology.
2. Introduce students to use the techniques, skills, and methods necessary for preventing corrosion and wear problems in industry.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Designs various methods to stop or decelerate the degradation of engineering materials.

2. Explain the pitting and crevice corrosion and prevention of them.
3. Describe the environmentally induced cracking and its prevention methods.
4. Describe erosion corrosion, biological corrosion, concrete corrosion and their prevention methods.
5. Determine the relations between the microstructure of the materials and the degradation behavior of the materials.
6. Explain the parameters of atmospheric corrosion and oxidation kinetics
7. Explain the galvanic corrosion and prevention methods. Calculate the required properties.
8. Explain the degradation principles of various ceramics.
9. Explain degradation principles of composites and polymeric materials.

Teaching-learning Strategy: Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by the instructor.

Mapping of course LO and Program Outcome:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Designs various methods to stop or decelerate the degradation of engineering materials.			√									
2. Explain the pitting and crevice corrosion and prevention of them.	√											
3. Describe the environmentally induced cracking and its prevention methods.		√										
4. Describe erosion corrosion, biological corrosion, concrete corrosion and their prevention methods.							√					
5. Determine the relations between the microstructure of the materials and					√							

the degradation behavior of the materials.												
6. Explain the parameters of atmospheric corrosion and oxidation kinetics	√											
7. Explain the galvanic corrosion and prevention methods. Calculate the required properties.	√											
8. Explain the degradation principles of various ceramics.		√										
9. Explain degradation principles of composites and polymeric materials.		√										

Text and Ref Books:

1. **Corrosion: Understanding the Basics**, J. R. Davis, ASM International, 2000.
2. **Engineering Tribology**, Gwidon Stachowiak, A W Batchelor, Butterworth-Heinemann, 2005
3. **Corrosion Engineering**, Pierre R. Roberge, Hill Professional 2008
4. **Corrosion. Engineering, 3rd ed**., Mars G. Fontana, McGraw-Hill, 1986.
5. **Corrosion Prevention and Protection: Practical Solutions,** Edward Ghali, Vedula S. Sastri, M. Elboujdaini, 2007.

DIVISION OF SPACE AND AEROSPACE VEHICLE DESIGN

Course Title: Advanced Aircraft Designing and Optimization

Course Code: AEAS 6191

Pre-requisite: Aircraft Design, Aircraft Stability and Control, Aircraft Performance.

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

This course aims to advance your skills as an aerospace professional engineer in the area of aircraft design. The course builds on the main principles underlying aircraft design, including the different design phases and the impact of specifications and relevant standards and regulations in the design process. The use of Systems Engineering principles will be covered as a complementary tool to provide a thorough understanding of all the development stages of an aircraft, from cradle to grave.

Based on the design requirements set for an aerospace vehicle or component, learn how to use sizing methods to develop adequate conceptual designs and utilize both analytical and numerical tools to address key areas in the detail design of an aircraft (such as aerodynamics, structures, propulsion, performance, stability and systems). Introduced to multidisciplinary systems design optimization tools to develop complex engineering solutions benefiting from the best trade-off between performance and efficiency.

Course Contents:

There is need for a rigorous, quantitative multidisciplinary design methodology that works with the non-quantitative and creative side of the design process in engineering systems. The goal of multidisciplinary systems design optimization is to create advanced and complex engineering systems that must be competitive not only in terms of performance, but also in terms of life-cycle value. The objective of the course is to present tools and methodologies for performing system optimization in a multidisciplinary design context. Focus will be equally strong on all three aspects of the problem: (i) the multidisciplinary character of engineering systems (ii) design of these complex systems and (iii) tools for optimization.Ordinary minimum problems with constraints, The classical multiplier method, descent methods, and quasi-Newton methods, Optimal control and the maximum principle. Second-order necessary conditions, Singular control, Continuous gradient methods, conjugate gradients, Introduction to Airframe Systems; Systems Design Philosophy and Safety; Aircraft Secondary Power Systems; Aircraft Pneumatics Power Systems; Aircraft Hydraulics Power Systems; Aircraft Electrical Power Systems; Flight Control Power Systems;

Aircraft Environmental Control; Aircraft Oxygen Systems; Aircraft Icing and Ice Protection Systems; Aircraft Emergency Systems; Aviation Fuels and Aircraft Fuel Systems; Engine Off-Take Effects; Fuel Penalties of Systems; Advanced & Possible Future Airframe Systems, Aircraft Design and MDO.

Objective:

1. Introduction of design philosophies like damage tolerance, safe- life, fail-safe
2. Introduction of the aircraft data requirements and description of the critical air loads used in the design and analysis of aircraft structures
3. Introduction of the aero-elastic stability design constraint
4. To describe an aircraft design phase like conceptual, preliminary and detail
5. To generate a first estimation of the new aircraft weight
6. To analyze the critical performance parameters for the new aircraft.

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Apply different design methodologies according with the specificity of the distinct aircraft design phases;
2. Use relevant standards and applicable regulations in the aircraft design process, understanding their impact on the definition of the design requirements;
3. Understand and apply systems engineering principles to the development of an aircraft considering its complete life cycle;
4. Generate, using creative techniques, credible design concepts for aerospace systems based on a set of engineering requirements;
5. Use analytical and numerical tools to perform multidisciplinary analysis, including the estimation of performance parameters and aircraft sizing in key areas (structure, propulsion, aerodynamics, stability and systems);
6. Apply and understand the relevance of optimization techniques to meet predefined design requirements;
7. Demonstrate effective team working and project management skills in an aerospace design project;

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by the instructor.

Mapping of course LO and Program Outcome:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Apply different design methodologies according with the specificity of the distinct aircraft design phases;		√										
2. Use relevant standards and applicable regulations in the aircraft design process, understanding their impact on the definition of the design requirements;			√									
3. Understand and apply systems engineering principles to the development of an aircraft considering its complete life cycle;	√											
4. Generate, using creative techniques, credible design concepts for aerospace systems based on a set of engineering requirements;					√							
5. Use analytical and numerical tools to perform multidisciplinary analysis, including the estimation of performance parameters and aircraft sizing in key areas (structure, propulsion, aerodynamics, stability and systems);						√						

6. Apply and understand the relevance of optimisation techniques to meet predefined design requirements;							√					
7. Demonstrate effective team working and project management skills in an aerospace design project;									√			

Text and Ref Books:

1. Software and computational facilities are available for **computer aided design (CAD), finite element analysis (FEA)** and **computational fluid dynamics (CFD).**
2. **Aircraft Design: A systems of Engineering Approach**, Mohammad H. Saddaey
3. **Aircraft Design: A Conceptual Approach**, Raymer, 3rd Ed; AIAA Virginia, 1999.
4. **Airplane Design**, John Roskam
5. **Launch Vehicle Design**, He Linshu, BUAA

Course Title: Advanced Aircraft Stability and Control

Course Code: AEAS 6192

Pre-requisite: Aircraft Stability and Control.

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

The course will provide content that will Understand and use the core theory of flight dynamics, turbulence and signal processing to solve real engineering problems; Understand and use control theory for solving theoretical and practical problems; and Use theory presented in this course to solve practical flight dynamics and handling problems of aircraft.

Course Contents:

Stability, control and handling qualities relationships; Aircraft aerodynamic controls: Control characteristics and balancing, trim and flight with asymmetric power; Static equilibrium and trim; Longitudinal static stability, trim, pitching moment equation, static margins; Maneuverability:- steady pull-up maneuver, pitching moment in maneuver, longitudinal maneuver stability, maneuver margins; Lateral-directional static stability; Handling and trim with asymmetric power; Introduction to dynamic stability: Equations of motion, phugoid mode, short period pitch mode, roll mode, spiral mode, Dutch-roll mode; Handling qualities assessment; Rating scales.

Objective:

1. Understand and use the core theory of flight dynamics
2. Use theory presented in this course to solve practical flight dynamics and handling problems of aircraft.
3. provide the opportunity to develop research competence and apply individual and independent thought to the understanding or solution to a problem through an advanced directed research project with full Stability analysis.
4. Understand and use control theory for solving theoretical and practical problems;

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Analyze the static stability of aircraft;.
2. Calculate and use the rigid body equations of motion for an aircraft.
3. Analyze the longitudinal and lateral dynamic stability of aircraft.
4. Analyze the static stability of helicopter and Apply the principles learned during the advanced topics sections (e.g. turbulence control, etc);

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by the instructor.

Mapping of course LO and Program Outcome:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Analyse the static stability of aircraft;.		√										
2. Calculate and use the rigid body equations of motion for an aircraft.			√									
3. Analyse the longitudinal and lateral dynamic stability of aircraft.		√										
4. Analyse the static stability of helicopter and Apply the principles learned during the advanced topics sections (e.g. turbulence control, etc);		√										

Text and Ref Books:

1. **Dynamics of Flight: Stability and Control.** Etkin, Bernard, and Lloyd Duff Reid. 3rd ed. New York: Wiley,
2. **Flight Stability and Automatic Control. Nelson**, Robert C. 2nd ed. Boston, MA: McGraw Hill, 1997.
3. **Flight Dynamics Principles.** Cook, M. V. London: Arnold,
4. **Airplane Performance Stability and Control.** Perkins, C., and R. Hage. 1st ed. New York: Wiley, 1949.
5. **Aircraft Control and Simulation**. Stevens, B., and F. Lewis. 2nd ed. New York: Wiley-Interscience, 2003..

6. **Automatic Control of Aircraft and Missiles.** Blakelock, John H. 2nd ed. New York: Wiley-Interscience, 1991.
7. **Aircraft Performance Stability and Control**, Vol-I, James D; Lang United States Air Force Academy.
8. **Mechanics of Flight**, Warren F. Phillips, Wiley, 2004
9. **Flight Mechanics**, A. Miele, Addison-Wesley Pub. Co, 1962

Course Title: Advanced Aircraft Performance

Course Code: AEAS 6193

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to analyze the performance of an aircraft with considering various performance criteria.

Course Contents:

Flight path performance: mission definition and breakdown into basic elements: airworthiness considerations; Cruise performance, specific air range and specific endurance, range and endurance under different cruise strategies and fuel flow laws; Climb and descent performance, airspeeds for optimum climb gradient and rate, one-engine-inoperative climb; Take-off and landing performance, definitions of speeds and distances, airworthiness considerations; Performance summaries.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Defining the motions of aircraft and the preformance criteria.
2. Analyzing steady-level flight and its performance criteria.
3. Analyzing steady climb flight and its performance criteria.
4. Analyzing steady descend flight/gliding and its performance criteria.
5. Analyzing (coordinated) turn flight and its performance criteria.

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Defining the motions of aircraft and the preformance criteria.		✓	✓									
2. Analyzing steady-level flight and its performance criteria.	✓											

3. Analyzing steady climb flight and its performance criteria.		✓										
4. Analyzing steady descend flight/gliding and its performance criteria.				✓								
5. Analyzing (coordinated) turn flight and its performance criteria.		✓										

Text and Ref Books:

4. Antonio Filippone, **Advanced Aircraft Flight Performance (Cambridge Aerospace Series)**
5. Anderson.J.D. **Aircraft Performance & Design**.

Course Title: Aircraft Accident Investigation

Course Code: AEAS 6194

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to introduce to regulatory foundations of aircraft accident investigation and investigative techniques specific to major accident investigations.

Course Contents:

The purpose of Accident Investigation, its history and development; Contrasting the aims of punitive and no-blame investigations; The role of the Investigation Branches, ICAO Annex 13 legislative frameworks; Roles and Responsibilities, requirements for notification, participation, and reporting; The functions of the investigator; Accident Causation and Investigative Approaches; Causation theory including multiple causality, systemic investigation, the concept of blame; Crisis Management and Media Management; Managing the accident site and the investigation; Engineering Investigations; Case studies which focus on technical failures; Data Recorders; Including flight data recorders and cockpit voice recorders; Operations Investigations; A case study from the inspector in charge of the Lockerbie disaster; Analysis Techniques for establishing what factors were causal, contributory or circumstantial; Military Investigations; Differences between civil and military investigations including the Board of Inquiry System, Fast Jets, Marine Recovery and Helicopter accidents; The manufacturer and the Investigator; The role of the investigator as technical rep to an investigation; Reporting and Change Management; Investigation report writing and change management within the safety system.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Differentiate between an accident and incident;
2. Apply an understanding of the different steps of an investigation process;
3. Describe the roles and responsibilities of an investigator;
4. Detail the responsibilities of operators and other authorities within investigations;
5. Describe the impact of human factors on the contributory factors behind an occurrence;

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO) and Program Outcomes:

Learning Outcomes (Los) of this course	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1.Differentiate between an accident and incident		✓	✓									
2.Apply an understanding of the different steps of an investigation process	✓											
3.Describe the roles and responsibilities of an investigator;		✓										
4.Detail the responsibilities of operators and other authorities within investigations;				✓								
5.Describe the impact of human factors on the contributory factors behind an occurrence;		✓										

Text and Ref Books:

1. Wood, R. - **Aircraft Accident Investigation**
2. Walters - **Aircraft Accident Analysis: Final Reports**

Course Title: Reliability, Safely Assessment and Certification

Course Code: AEAS 6195

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to introduce to reliability requirements, failure mode and effects analysis and system safety assessment.

Course Contents:

Reliability: Reliability requirements, Probabilities of failure, MTBF, MTBR, etc., Reliability models –series and parallel systems, common mode failures; Safety Assessment Analysis Methods: Failure Modes and Effects Analysis (FMEA), Fault Tree Analysis (FTA), Reliability predictions, Common Cause Analysis (CCA); System Safety Assessment Process: Functional Hazard Analysis (FHA), Preliminary System Safety Assessment (PSSA), System Safety Assessment (SSA), Weapon Systems, Combat Aircraft Survivability, Certification Process.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Understand the reliability requirements
2. Apply an understanding of the different steps of safety assessment analysis
3. Describe the roles of failure mode and effect analysis
4. Detail the process of functional hazard analysis
5. Describe the impact of weapon system and certification process

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO) and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Understand the reliability requirements		✓	✓									
2. Apply an understanding of the different steps of	✓											

safety assessment analysis												
3. Describe the roles of failure mode and effect analysis		✓										
4. Detail the process of functional hazard analysis				✓								
5. Describe the impact of weapon system and certification process		✓										

Text and Ref Books:

1. Villemeur, A. Reliability, Availability, Maintainability and Safety Assessment, Volume 2, Assessment, Hardware, Software and Human Factors

Course Title: Crashworthiness

Course Code: AEAS 6196

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to obtain a fundamental appreciation of the principles of crashworthiness.

Course Contents:

Introduction to crashworthiness; Local collapse of structures: Collapse of thick walled sections: axial, bending and torsion; Collapse of thin walled sections, energy absorption and failure modes; Global collapse of structures: Virtual work approach to calculation, identification of collapse mechanism, geometric and large deformation effects; Crash energy management: Modes of energy absorption, collapse mechanism control, dynamic effects; Crashworthiness design features: Context of structural design in overall crashworthiness, relation to other design aspects; Issues specific to individual applications, including aircraft, cars, trains; Occupant protection: Injury mechanisms, crash dummies and injury criteria; Test and analysis methods: Experimental crash tests, hybrid analysis methods.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Perform analyses of vehicle structures dynamics during crash.
2. Demonstrate methods for vehicle and component design to reduce accident injury levels.
3. Apply computation methods for analysing main vehicle structure components' behaviour during crash.
4. Evaluate and explain possible methods and techniques for active and passive safety.
5. Illustrate the interrelation between occupants and vehicle restraint systems

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.
Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12

1. Perform analyses of vehicle structures dynamics during crash.		✓	✓									
2. Demonstrate methods for vehicle and component design to reduce accident injury levels.	✓											
3. Apply computation methods for analysing main vehicle structure components' behaviour during crash.		✓										
4. Evaluate and explain possible methods and techniques for active and passive safety.				✓								
5. Illustrate the interrelation between occupants and vehicle restraint systems		✓										

Text and Ref Books:

1. Johnson W. Mamalis, **Crashworthiness of Vehicles**

AVIONICS DISCIPLINE

Course Title: Inertial & Satellite Navigation System

Course Code: AEAV 6211

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to obtain a fundamental appreciation of the principles of Inertial & Satellite Navigation System.

Course Contents:

Inertial sensor technology-Accelerometers, Gyroscopes, Inertial sensor specifications, Mechanization equations- Coordinate systems, position and direction cosine matrixes, quaternion equations, Inertial navigation algorithms and computation, Inertial system error analysis, Inertial navigation systems design, Overview of GNSS – GPS, GLONASS, GALILEO and other systems-Space segment - satellites, orbit planes and altitudes, Ground segment - distributed control and monitoring stations, User segment – various kinds of user receivers,GPS positioning principles-Signal structure, Positioning and attitude determination algorithms, GPS error analysis, GPS integrity monitoring, GPS receiver design, Augmentation of GNSS-Space based augmentation, Ground based augmentation, Avionics based augmentation, GNSS Aviation Applications-GNSS for positioning, navigation and landing, GNSS for precise time dissemination, Differential GNSS and Test Range Applications.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Perform analyses of inertial sensor technology.
2. Demonstrate types for mechanization equations.
3. Apply knowledge about GNSS – GPS, GLONASS, GALILEO and other space segment satellites.
4. Evaluate and explain GPS positioning principles, Signal structure, Positioning and attitude determination algorithms.
5. Illustrate the applications of GNSS.

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Perform analyses of inertial sensor technology		✓	✓									
2. Demonstrate types for mechanization equations.	✓											
3. Apply knowledge about GNSS – GPS, GLONASS, GALILEO and other space segment satellites.		✓										
4. Evaluate and explain GPS positioning principles, Signal structure, Positioning and attitude determination algorithms.				✓								
5. Illustrate the applications of GNSS.		✓										

Text and Ref Books:

1. Barton, C. Global Navigation Satellite Systems, Inertial Navigation, and Integration

Course Title: Integrated Navigation System

Course Code: AEAV 6212

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to obtain a fundamental appreciation of the principles of Integrated Navigation System.

Course Contents:

Kalman Filter techniques-Fundamentals, matrix and probability theories, System dynamic models, Linear Kalman filter, Linearised and Extended Kalman filters, Statistical characteristics of Kalman Filters, Navigation System Error Dynamic Models-Inertial system error models, GNSS positioning and attitude determination models, Integrated Navigation System design-Integrated navigation system architectures, Integrated Kalman filter architectures, Integrated navigation algorithm design, Case study-Redundant inertial/Doppler/Air data/GPS integrated navigation systems.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Perform analyses of Kalman filter techniques.
2. Demonstrate types for navigation system error dynamic models.
3. Apply knowledge about GNSS positioning and attitude determination models.
4. Evaluate and explain Integrated Kalman filter architectures.
5. Illustrate the case studies of redundant inertial/doppler/air data/gps integrated navigation systems.

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12

1. Perform analyses of Kalman filter techniques.		✓	✓									
2. Demonstrate types for navigation system error dynamic models.	✓											
3. Apply knowledge about GNSS positioning and attitude determination models.		✓										
4. Evaluate and explain Integrated Kalman filter architectures.				✓								
5. Illustrate the case studies of redundant inertial/doppler/air data/gps integrated navigation systems.		✓										

Text and Ref Books:

1. Groves, P. Principles of GNSS Inertial and Multi-Sensor Integrated Navigation System
2. Andrews, A. Kalman Filtering: Theory and Practice with MATLAB

Course Title: Missile Guidance

Course Code: AEAV 6213

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to obtain a fundamental appreciation of the principles of missile guidance.

Course Contents:

Principles of tactical and strategic missile guidance, mathematical concepts, heuristic perspective, numerical examples, Interceptor guidance system technology, How subsystems influence total system performance, Useful design relationships for rapid guidance system sizing, Using adjoints to analyze missile guidance systems, How various guidance laws can improve system performance, Factors which limit missile system performance.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Perform analyses of tactical and strategic missile guidance.
2. Demonstrate knowledge of interceptor guidance system technology.
3. Apply knowledge about useful design relationships for rapid guidance system sizing.
4. Evaluate and explain how various guidance laws can improve system performance.
5. Illustrate the factors which limit missile system performance

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Perform analyses of tactical and strategic missile guidance.		✓	✓									

2. Demonstrate knowledge of interceptor guidance system technology.	✓											
3. Apply knowledge about useful design relationships for rapid guidance system sizing.		✓										
4. Evaluate and explain how various guidance laws can improve system performance.				✓								
5. Illustrate the factors which limit missile system performance		✓										

Text and Ref Books:

1. Zarchan, P. Tactical and Strategic Missile Guidance.
2. Siouris, G. Missile Guidance and Control Systems

Course Title: Flight Dynamics and Control

Course Code: AEAV 6214

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to obtain a fundamental appreciation of the principles of flight dynamicsa and control.

Course Contents:

Static stability and trim; stability derivatives and characteristic longitudinal and lateral-directional motions; physical effects of the wing, fuselage, and tail on aircraft motion. Flight vehicle stabilization by classical and modern control techniques; time and frequency domain analysis of control system performance; human pilot models and pilot-in-the-loop controls with applications, Parameter sensitivity; handling quality analysis of aircraft through variable flight conditions, Introduction to nonlinear flight regimes.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Perform analyses of stability derivatives and characteristic longitudinal and lateral-directional motions.
2. Demonstrate knowledge of physical effects of the wing, fuselage, and tail on aircraft motion.
3. Apply knowledge about time and frequency domain analysis of control system performance.
4. Evaluate and explain human pilot models and pilot-in-the-loop controls with applications.
5. Illustrate handling quality analysis of aircraft through variable flight conditions.

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	Program Outcomes

	1	2	3	4	5	6	7	8	9	10	11	12
1. Perform analyses of stability derivatives and characteristic longitudinal and lateral-directional motions.		✓	✓									
2. Demonstrate knowledge of physical effects of the wing, fuselage, and tail on aircraft motion.	✓											
3. Apply knowledge about time and frequency domain analysis of control system performance.		✓										
4. Evaluate and explain human pilot models and pilot-in-the-loop controls with applications.				✓								
5. Illustrate handling quality analysis of aircraft through variable flight conditions.		✓										

Text and Ref Books:

1. Etkin, B. Dynamics of Flight: Stability and Control.
2. Cook, M. Flight Dynamics Principles.

Course Title: Linear Systems Theory

Course Code: AEAV 6215

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to obtain a fundamental appreciation of the principles of linear systems theory.

Course Contents:

Theory for linear multivariable systems, state space models, discretization, canonical forms and realizations, Lyapunov stability, controllability and observability, state feedback, LQ control, state estimation, the Kalman filter, descriptions of stochastic processes and random signals.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Perform analyses of theory for linear multivariable systems.
2. Demonstrate knowledge of state space models, discretization, canonical forms and realizations.
3. Apply knowledge about Lyapunov stability, controllability and observability.
4. Evaluate and explain the working of the Kalman filter.
5. Illustrate descriptions of stochastic processes and random signals.

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Perform analyses of theory for linear multivariable systems.		✓	✓									

2. Demonstrate knowledge of state space models, discretization, canonical forms and realizations.	✓											
3. Apply knowledge about Lyapunov stability, controllability and observability.		✓										
4. Evaluate and explain the working of the Kalman filter.				✓								
5. Illustrate descriptions of stochastic processes and random signals.		✓										

Text and Ref Books:

1. Hespanha, P. Linear Systems Theory.
2. Chen, C. Linear System Theory and Design.

Course Title: Probability and Random Processes

Course Code: AEAV 6216

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to obtain a fundamental appreciation of the principles of probability and random processes.

Course Contents:

Definitions, scope and history; limitation of classical and relative-frequency-based definitions, Sets, fields, sample space and events; axiomatic definition of probability, Combinatorics, Joint and conditional probabilities, independence, total probability; Bayes' rule and applications, Random variables-Definition of random variables, continuous and discrete random variables, cumulative distribution function (cdf) for discrete and continuous random variables; probability mass function (pmf); probability density functions (pdf) and properties, Jointly distributed random variables, conditional and joint density and distribution functions, independence; Bayes' rule for continuous and mixed random variables Function of random a variable, pdf of the function of a random variable; Function of two random variables; Sum of two independent random variables, Expectation: mean, variance and moments of a random variable, Joint moments, conditional expectation; covariance and correlation; independent, uncorrelated and orthogonal random variables, Random vector: mean vector, covariance matrix and properties Some special distributions: Uniform, Gaussian and Rayleigh distributions; Binomial and Poisson distributions; Multivariate Gaussian distribution, Vector-space representation of random variables, linear independence, inner product, Schwarz Inequality, Elements of estimation theory: linear minimum mean-square error and orthogonality principle in estimation, Moment-generating and characteristic functions and their applications, Bounds and approximations: Chebysev inequality and Chernoff Bound, Sequence of random variables and convergence, Random process-Random process, Probabilistic structure of a random process; Stationarity, Ergodicity and its importance, Spectral representation of a real WSS process, Linear time-invariant system with a WSS process as an input, Spectral factorization theorem Examples of random processes.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Perform analyses of limitation of classical and relative-frequency-based definitions of probability and random processes.
2. Demonstrate knowledge of Bayes' rule and applications.

3. Apply knowledge about mean, variance and moments of a random variable, joint moments, conditional expectation; covariance and correlation.
4. Evaluate and explain elements of estimation theory: linear minimum mean-square error and orthogonality principle in estimation.

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Perform analyses of limitation of classical and relative-frequency-based definitions of probability and random processes.		✓	✓									
2. Demonstrate knowledge of Bayes' rule and applications.	✓											
3. Apply knowledge about mean, variance and moments of a random variable, joint moments, conditional expectation; covariance and correlation.		✓										
4. Evaluate and explain elements of estimation theory: linear minimum mean-square error and orthogonality principle in estimation.				✓								

Text and Ref Books:

1. Grimmett, G. Probability and Random Processes.
2. Pishro-Nik, H. Introduction to Probability, Statistics, and Random Processes.

Course Title: Advanced Control Systems

Course Code: AEAV 6217
Level: Post-graduation program
Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to obtain a fundamental appreciation of the principles of advanced control systems.

Course Contents:

Feedback control system characteristics, Control system performance, Stability of Linear Feedback Systems, Root locus method, Frequency response method, Nyquist stability, Classical controller design, State variable controller design, Robust control.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Perform analyses of feedback control system characteristics.
2. Demonstrate knowledge of control system performance.
3. Apply knowledge about stability of linear feedback systems.
4. Evaluate and explain root locus method, frequency response method, nyquist stability.
5. Illustrate classical and state variable controller design.

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Perform analyses of feedback control system characteristics.		✓	✓									
2. Demonstrate knowledge of control system performance.	✓											
3. Apply knowledge about stability of linear feedback systems.		✓										
4. Evaluate and explain root locus method, frequency response method, nyquist stability.				✓								
5. Illustrate classical and state variable controller design.		✓										

Text and Ref Books:

1. Norman, N. Control Systems Engineering.
2. Smith, C. Principles and Practices of Automatic Process Control.

Course Title: Cockpit Environment

Course Code: AEAV 6218

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

The purpose of this course is to obtain a fundamental appreciation of the principles of cockpit environment.

Course Contents:

The flight deck – A historical perspective, Cockpit layout - modern military and civil scenarios, Principles of Aircraft Instrumentation and Sensors, Flight Instruments - The Basic-T, engines, systems, other interface layouts, Displays-Electro-mechanical displays, Head down displays – CRTs and AMLCDs. Drivers, functions, technologies and performance, Head up displays; Drivers, functions, technologies and performance, Helmet mounted displays, Drivers, functions, technologies and performance, cockpit experience. Hands-on simulator demonstration, Flight Control- Traditional flight control systems, Fly-by-wire. Drivers, technologies, integrity, value, flight envelope control. A-320 case study, Situational Awareness- The advanced / modern cockpit; Challenges of information transfer in a complex, environment and advanced machines; Pitfalls, with case studies (incl. B757 accident in Latin America, A320 accident in France), Alert prioritization. The dark and silent cockpit concept, CFIT awareness – TAWS – technologies and purpose, Traffic awareness – TCAS – technologies and purpose, Advanced Concepts-4D navigation, Tunnel-in-the-sky and other navigational aids, FLIR and night vision goggles – technologies, Enhanced vision – techniques and characteristics, Synthetic vision – databases and graphics generation. Characteristics and limitations.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Perform analyses of cockpit layout - modern military and civil scenarios.
2. Demonstrate knowledge of principles of aircraft instrumentation and sensors.
3. Apply knowledge about flight control- traditional flight control systems, fly-by-wire.
4. Evaluate and explain challenges of information transfer in a complex, environment and advanced machines.
5. Illustrate the dark and silent cockpit concept.

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Perform analyses of cockpit layout - modern military and civil scenarios.		✓	✓									
2. Demonstrate knowledge of principles of aircraft instrumentation and sensors.	✓											
3. Apply knowledge about flight control-traditional flight control systems, fly-by-wire.		✓										
4. Evaluate and explain challenges of information transfer in a complex, environment and advanced machines.				✓								
5. Illustrate the dark and silent cockpit concept.		✓										

Text and Ref Books:

1. Spitzer, C. Digital Avionics Handbook.
2. Helfrick, A. Principles of Avionics.

Course Title: Instrumentation and Measurement for Aerospace Applications

Course Code: AEAV 6219

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (Per Week)

Rationale:

Identifying various aircraft instruments, their use, different errors associated with the instruments and how to minimize such errors.

Course Contents:

Fundamentals: Generalized measurements systems, dimensions and units of measurements, causes and types of experimental errors, error and uncertainty analysis.

Air pollution sampling and measurements; Data acquisition and processing.

Introduction: Introduction to Basic-6 and Basic-T aircraft instruments, applications of instruments in aircraft, functional elements of a measurement system and classification of instruments.

Instrument display and layout: Qualitative, quantitative display, scale range, operating range, type of scales- linear, non-linear, circular, straight, dual displays and digital display; instrument grouping in cockpit.

Transducers: Primary, secondary, mechanical, electrical and optical.

Measurement of non-electrical quantities: Temperature, pressure, flow, level, force and torque.

Pitot-static group of Instruments: ASI, Altimeter, VSI, Mach meter: Construction, operating principle, square law compensation, introduction to Air Data Computer, TAS, CAS, IAS

Aircraft Attitude & Indication system: Gyroscope & properties- Precession & rigidity, Gyro Horizon Indicator, Turn & Bank Indicator, construction and operating principle.

Measurement of Engine RPM: Torque measurement, Tacho probe.

Temperature Measurement: Thermocouple, Radiation pyrometer, PRTD, air temperature sensors-Principle application in aviation

Fuel flow and quantity measurement: Resistive & Capacitive transducer, aircraft fuel measurement system, compensation for aircraft attitude and non-uniform tank contour.Basic elements of signal conditioning: Instrumentation amplifier, noise and source of noise, noise elimination compensation, A/D and D/A converters, sample and hold circuits. Data acquisition system.Digital Data Transmission Lines: Data buses, MIL STD 1553, ARINC 429, Optical data buses.

Learning Outcomes (LO):

The course provides the student with knowledge about:

1. Analyze the functioning of the flight instruments and power plant instruments in the aircraft system with different types of data displays.
2. Explain the working of airspeed, altitude, vertical speed, Mach, TAS, CAS, and IAS measuring syste

3. Analyze the fuel flow and quantity measurement, signal conditioning system and digital data transmission lines.

Teaching-learning Startegy: Lectures, class performances, assignments, Class tests, final exam.

Assessment Strategy: As specified by the instructor

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (Los) of this course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Analyze the functioning of the flight instruments and power plant instruments in the aircraft system with different types of data displays.		✓										
2. Explain the working of airspeed, altitude, vertical speed, Mach, TAS, CAS, and IAS measuring system	✓											
3. Analyze the fuel flow and quantity measurement, signal conditioning system and digital data transmission lines.		✓										

Text and Ref Books:

1. Aircraft Instruments and integrated Systems- EHJ Pallet; Pearson Education Publishers.
2. Aircraft Electricity and Electronics- Thomas Eismin; Glencoe.
3. Modern Electronic Instrumentation and Measurement Techniques - Albert D Helfrick; Prentice Hall of India private Ltd.
4. Federal Aviation Agency (FAA) Hand Book of Flying: Flight Instruments.
5. Electrical Electronics Measurement and Instrumentation - A.K. Sawheney; Dhanpat Rai and Company Private Ltd.

Course Title: Signal Analysis and Processing

Course Code: AEAV 6231

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale:

To provide an understanding and working familiarity with the fundamentals of digital signal processing and is suitable for a wide range of people involved with and/or interested in digital filters and signal processing applications.

Objective:

1. To give the students a comprehension of the concepts of discrete-time signals and systems
2. To give the students a comprehension of the Z- and the Fourier transform and their inverse
3. To give the students a comprehension of the relation between digital filters, difference equations and system functions
4. To give the students knowledge about the most important issues in sampling and reconstruction
5. To make the students able to apply digital filters according to known filter specifications
6. To provide the knowledge about the principles behind the discrete Fourier transform (DFT) and its fast computation
7. To make the students able to apply Fourier analysis of stochastic signals using the DFT
8. To be able to apply the MATLAB programme to digital processing problems and presentations.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Explain basics of discrete-time signal systems.

2. Identify the discrete, continuous and special distributions, sampling and estimation, significant tests.

3. Interpret digital filters and apply MATLAB to solve digital filters.

Course Contents:

Revision of complex algebra, Important generalized functions, Series representation of period signals, Fourier analysis and the Fourier transforms, convolution and correlation, The Sampling theorem, The Z transform, Probability and statistics: discrete, continuous and special distributions,

sampling and estimation, significant tests, Discrete-time signals and systems, correlation of discrete-time signals, Discrete Fourier transform, Power spectral density, Short time Fourier transform, Wavelet transform, Wigner distribution, Classical and adaptive digital filtering.

Teaching-learning Strategy : Lectures, class performances, assignments, class tests, final exam.
Assessment Strategy: As convenient by instructor.
Linkage of LO with Assessment Methods& their Weights: As convenient by instructor.
Mapping of Course LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this Course	**Program Outcomes (PO)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Explain basics of discrete-time signal systems.	√											
2. Identify the discrete, COntinuous and special distributions, sampling and estimation, significant tests.		√										
3. Interpret digital filters and apply MATLAB to solve digital filters.			√									

Text and Ref Books:

1. Linear Algebra, Signal Processing, and Wavelets - A Unified Approach: Python Version (Springer Undergraduate Texts in Mathematics and TechnoCOgy) - Øyvind Ryan
2. Time-Frequency Signal Analysis and Processing: A COmprehensive Reference (Eurasip and Academic Press Series in Signal and Image Processing) - Boualem Boashash
3. Fourier Analysis—A Signal Processing Approach - D. Sundararajan

Course Title: Image Analysis and Processing

Course Code: AEAV 6232

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: Upon completion of this course, students will be familiar with basic image processing techniques for solving real problems. Student will also have sufficient expertise in both the theory of two-dimensional signal processing and its wide range of applications, for example, image restoration, image compression, and image analysis.

Objective:

1. Handle techniques of representation and approximation of images in order to extract their meaningful components with respect to a particular application, for example, in the fields of data transmission or interpretation
2. Apply linear and non-linear filtering operations (e.g., morphocogical) to isolate certain frequency components or to cancel particular noises;
3. Detect structures of interest in an image, such as contours, key features, etc..
4. Segment an image into regions of homogeneous characteristics, targeting a semantic interpretation of the image content;
5. Restore images corrupted a noise or a blurring;
6. Understand the basic principles of inverse problem solving in imaging and in compressed sensing;
7. Manage image databases using detection tools or classification;

Learning Outcomes (LO):

Upon Completion of the Course, the students will be able to:

1. Identify major processes involved in formation of images.
2. Recognize the imaging modality from their visualizations.
3. Classify the various image processing algorithms.
4. Describe fundamental methods for image enhancement.
5. Appraise efficacy and drawbacks of several techniques for image segmentation

Course Contents:

Image Applications, Image Representation, Image Capture Hardware, Image Sampling and Noise, Image Geometry and Cocality, Processing Operations upon Images, Camera Projection / Convolution Model, Image Transformation, Image Enhancement, Image Restoration, Image Compression, Image Feature Extraction and Processing, Image Segmentation, Basic Feature-based Classification Approaches

Teaching-learning Strategy : Lectures, class performances, assignments, class tests, final exam.
Assessment Strategy: As convenient by instructor.

Linkage of LO with Assessment Methods& their Weights: As convenient by instructor.

Mapping of LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this Course	**Program Outcomes (PO)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Identify major processes involved in formation of images.	√											

2. Recognize the imaging modality from their visualizations.		√										
3. Classify the various image processing algorithms.	√											
4. Describe fundamental methods for image enhancement.		√										
5. Appraise efficacy and drawbacks of several techniques for image segmentation.				√								

Text and Ref Books:

1. S. Birchfield, Image Processing and Analysis, Cengage Learning, 2016.
2. C. SoCOmon and T. Breckon, Fundamentals of Digital Image Processing: A Practical Approach with Examples in MATLAB, John Wiley & Sons, 2011.
3. K. R. Castleman, Digital Image Processing, Prentice Hall, 1996.
4. B. Jane, Digital Image Processing: Concepts, Algorithms, and Scientific Applications, Springer Verlag, 1995.
5. R. C. Gonzalez and R. E. Woods, Digital Image Processing, Prentice Hall, 2008
6. A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989.

Course Title: Advanced Antenna Theory and Design

Course Code: AEAV 6233

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: To provide an in-depth understanding of modern antenna concepts, and practical antenna design for various applications

Objective:

1. To explain the theory of different types of antennas used in communication systems.
2. To discuss various types of antennas including the planar printed antennas, starting from the basic antenna parameters.
3. To build in-depth study will be made for the analysis and design of arrays.
4. To introduce smart antenna concept will be given at the end with a view that the student can further expcore the topic.
5. To understand of antenna fundamentals and the know how of designing various kind of antennas such as dipole, coop, micrsotrip patch antennas and arrays

Learning Outcomes (LO):

Upon completion of the course, the students will be able :

1. To gather knowledge of radiation principles and antenna properties that are important for the choice of antenna solution in given situations.
2. To achieve in-depth insight into numerical methods for antenna calculations and the use of modern computer tools in antenna design.
3. To enable him or her to think creatively about the use of advanced antennas for sensors and communication purposes.
4. To be able to design, simulate, implement and use advanced antennas in radio systems based on overall system requirements.
5. To acquire advanced knowledge from the literature, evaluate different solutions and present results from his or her own designs and simulations.

Course Contents:

Introduction, Types of antennas, Radiation mechanism, Poynting vector, Steradian Concept, Power intensity, Antenna Parameters: Radiated power, Radiation pattern, Field regions, Antenna Parameters: Directivity, Gain, Antenna polarization, Antenna Parameters: Axial ratio, Input impedance, Reflection Coefficient, Return COss, VSWR, Antenna Parameters: Impedance bandwidth, Effective aperture; Communication link and Friis transmission equation, Radiation integrals and Auxiliary Potential Functions, Radiation from wires and Coops, Introduction, Infinitesimal dipole, Infinitesimal dipole: Radiation zones, Total radiated power, Radiation resistance, Directivity, Effective area, Short dipole, Finite-length dipole, Finite-length dipole: Radiated power, Radiation resistance, Directivity, Effective area, Half-wave dipole and its properties, Coop Antenna, Aperture Antenna: Introduction, Field equivalence principle, Cove's equivalence principle, Electrical and magnetic Conductor equivalence principle, Computation of field quantities of aperture antenna, Relation between wire and aperture antennas, Horn antenna design principle, Broadband Antenna, Micro-Strip Antenna, Antenna Arrays, Smart Antennas.

Teaching-learning Strategy : Lectures, class performances, assignments, class tests, final exam.
Assessment Strategy: As convenient by instructor.

Linkage of LO with Assessment Methods& their Weights: As convenient by instructor.
Mapping of LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this Course	**Program Outcomes (PO)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. To gather knowledge of radiation principles and antenna properties that are important for the choice of antenna solution in given situations.	√											

2. To achieve in-depth insight into numerical methods for antenna calculations and the use of modern COmputer tools in antenna design.					√							
3. To enable him or her to think creatively about the use of advanced antennas for sensors and COmmunication purposes										√		
4. To be able to design, simulate, implement and use advanced antennas in radio systems based on overall system requirements.			√									
5. To acquire advanced knowledge from the literature, evaluate different solutions and present results from his or her own designs and simulations.		√										

Text and Ref Books:

1. C.A.Balanis,"Antenna Theory and Design", 3 rd Ed., John Wiley & Sons., 2005. 2. W.

2. L.Stutzman, and G.A. Thiele,"Antenna Theory and Design", 2 nd Ed., John Wiley & Sons., 1998.
3. R.S.Elliot,"Antenna Theory and Design", Revised edition, Wiley-IEEE Press., 2003.
4. A. Balanis, Antenna Theory: Analysis and Design, 3rd Edition.
5. Wentworth, Fundamentals of Electromagnetics with Engineering Applications.

Course Title: Satellite Communication System

Course Code: AEAV 6234

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: Upon Completion of this Course, students will be familiar with an overview of Satellite communication and its applications in communication Engg.and understand the various terminocogy, principles, devices, schemes, concepts, algorithms and different methodocogies used.

Objective:

1. To enable the student to beCOme familiar with satellites and satellite services.
2. To study of satellite orbits and launching.
3. To study of earth segment and space segment COmponents
4. To study of satellite access by various users.
5. To provide them with a sound understanding of how a satellite COmmunication system successfully transfers information from one earth station to another.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Define orbital mechanics and launch methodocogies.
2. Describe satellite subsystems and study the design of Earth station and tracking of the satellites.
3. Design link power budget for satellites.
4. Compare competitive satellite services and explain satellite access techniques.
5. Pursue research in the area of space communication.

Course Contents:

Basic Principles-General features, frequency alcocation for satellite services, properties of satellite communication systems, **Satellite Orbits-**Introduction, Kepler's laws, orbital dynamics, orbital characteristics, satellite spacing and orbital capacity, angle of elevation, eclipses, launching and positioning, satellite drift and station keeping, **Satellite construction (Space Segment)-** Introduction; attitude and orbit control system; telemetry, tracking and command; power systems, communication subsystems, antenna subsystem, equipment reliability and space qualification, **The Space Segment Access and Utilization-**Introduction, space segment access methods, TDMA, FDMA, CDMA, SDMA, assignment methods, **The Role and Application of Satellite Communication, RF Integrated Circuits.**

Teaching-learning Strategy : Lectures, class performances, assignments, class tests, final exam.
Assessment Strategy: As convenient by instructor.

Linkage of LO with Assessment Methods& their Weights: As convenient by instructor.

Mapping of LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this Course	**Program Outcomes (PO)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Define orbital mechanics and launch methodocogies.	√											
2. Describe satellite subsystems and study the design of Earth station and tracking of the satellites.		√										
3. Design link power budget for satellites.			√									

4. Compare competitive satellite services and explain satellite access techniques.		√										
5. Pursue research in the area of space communication.												√

Text and Ref Books:

1. T. Pratt, Satellite COmmunications, John Wiley, 2002
2. T. T. Ha., Digital satellite COmmunication, COllier Macmillan, 1986
3. D. Roddy, Satellite COmmunication (4/e), McGraw- Hill, 2009.
4. B.N. Agrawal, Design of Geosynchrons Spacecraft, Prentice- Hall,1986.

Course Title: Advanced Digital Communication

Course Code: AEAV 6235

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: Aim is to identify the functions of different components and learn about theoretical bounds on the rates of digital communication system and represent a digital signal using several modulation methods and draw signal space diagrams compute spectra of modulated signals.

Objective:

1. To understand the building blocks of digital communication system.
2. To prepare mathematical background for communication signal analysis.
3. To understand and analyze the signal flow in a digital communication system
4. To analyze error performance of a digital communication system in presence of noise and other interferences.
5. To understand concept of spread spectrum communication system.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Analyze the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.
2. Perform the time and frequency domain analysis of the signals in a digital communication system.
3. Select the blocks in a design of digital communication system.
4. Analyze Performance of spread spectrum communication system.

Course Contents:

Introduction-Digital communication system (description of different modules of the block diagram), Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure. M-ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms, Modulation-Pulse amplitude modulation (binary and M-ary, QAM), Pulse position modulation (binary and M-ary), Carrier modulation (M-ary ASK, PSK, FSK, DPSK), Continuous phase modulation (QPSK and variants, MSK, GMSK). Receiver in additive white Gaussian noise channels-coherent and non-

coherent demodulation: Matched filter, Correlator demodulator, square-law, and envelope detection; Detector: Optimum rule for ML and MAP detection Performance: Bit-error-rate, symbol error rate for coherent and noncoherent schemes, Band-limited channels-Pulse shape design for channels with ISI: Nyquist pulse, Partial response signaling (duobinary and modified duobinary pulses), demodulation; Channel with distortion: Design of transmitting and receiving filters for a known channel and for time varying channel (equalization); Performance: Symbol by symbol detection and BER, symbol and sequence detection, Viterbi algorithm, Synchronization-Different synchronization techniques (Early-Late Gate, MMSE, ML and spectral line methods), Communication over fading channels-Characteristics of fading channels, Rayleigh and Rician channels, receiver performance-average SNR, outage probability, amount of fading and average bit/symbol error rate.

Teaching-learning Strategy : Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by instructor.

Linkage of LO with Assessment Methods& their Weights: As convenient by instructor.

Mapping of LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this Course	**Program Outcomes (PO)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Analyze the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.	√											
2. Perform the time and frequency domain analysis of the signals in a digital communication system.		√										
3. Select the blocks in a design of digital communication system.				√								
4. Analyze Performance of spread spectrum communication system.			√									

Text and Ref Books:

1. Simon Haykin, “Digital Communication Systems”, John Wiley&Sons, Fourth Edition.
2. A.B Carlson, P B Crully, J C Rutledge, “Communication Systems”, Fourth Edition, McGraw Hill Publication.
3. P Ramkrishna Rao, Digital Communication, McGrawHill Publication
4. Ha Nguyen, Ed Shwedyk, “A First Course in Digital Communication”, Cambridge University Press.
5. B P Lathi, Zhi Ding “Modern Analog and Digital Communication System”, Oxford University Press, Fourth Edition.
6. Bernard Sklar,Prabitra Kumar Ray, “Digital Communications Fundamentals and Applications” SeCOnd Edition,Pearson Education.
7. Taub, Schilling, “Principles of Communication System”, Fourth Edition, McGraw Hill.

Course Title: Radio Communication Systems

Course Code: AEAV 6236

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: This course is provided to gather knowledge about radio Communication, navigation and guidance systems for their proper implementation in future workplace or studies.

Objective:

1. To provide a fundamental understanding and knowledge of conventional and modern design and working principles of radar, guidance and navigation for air vehicles.

2. To provide the basic mathematical concepts of radar, navigation by NDB, VOR, GPS and Inertial Navigation approaches, and guidance laws.

3. To provide an expansive view into the technological trends of future aircraft navigation and guidance systems designs.

Learning Outcomes (LO):

Upon completion of the course, the students will be able to:

1. Demonstrate an understanding of the fundamentals methods of navigation, radio direction finding, automatic direction finder and radio compass.

2. Analyze various navigation components like VOR, DME, ILS, MLS, Secondary Radar, TCAS etc.

3. Understand the working principle of Doppler navigation, its beam configuration and frequency spectrum analysis.

4. Analyze different radio navigation components such as non-directional beacon and radio direction finding, loop antenna, sense aerial, radio altimeter etc.

5. Analyze the basic operating principle and function of Flight management system.

Course Contents:

Electro-Magnetic Waves and Radio Propagation-The EM spectrum, properties and propagation, Radio Transmission: COS and beyond COS transmission, Antenna Multiplexing and modulation. Spread spectrum techniques, Airborne Communication systems, voice Communication – HF, VHF, selcal, SATCOMs, Data Communication – civil and military datalinks, Thermal imagery. IR properties, black-body radiation, Terrestrial Navigation-Terrestrial Radio Navigational Aids-DF, NDB, MB, VOR & DVOR, DME, ILS, MLS, TACAN, Doppler Navigation, Radar-Basic principles, Principle of operation and Radar Equations, Radar Components – Transmitter, Antenna, Receiver, Operational modes: CW, pulsed, pulsed Compression, SAR, Radar applications – tracking systems, weather radar, radar altimeter, Radar cross-section and stealth technology.

Teaching-learning Strategy : Lectures, class performances, assignments, class tests, final exam.
Assessment Strategy: As convenient by instructor.

Linkage of CO with Assessment Methods& their Weights: As convenient by instructor.

Mapping of Course CO and Program Outcomes (PO):

Learning Outcomes (COs) of this Course	**Program Outcomes (PO)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Demonstrate an understanding of the fundamentals methods of navigation, radio direction finding, automatic direction finder and radio Compass.	√											
2. Analyze various navigation Components like VOR, DME, ILS, MLS, Secondary Radar, TCAS etc.					√							
3. Understand the working principle of Doppler navigation, its beam Configuration and frequency spectrum analysis.	√											
4. Analyze different radio navigation Components such as non-directional beacon and radio direction finding, loop antenna, sense aerial, radio altimeter etc.					√							
5. Analyze the basic operating principle and function of Flight management system.	√											

Text and Ref Books:

1. Avionics Fundamentals- Jeppesen; Highflyn.

2. Principles of Avionics - Albert Helfrick; Avionics COmmunication.

3. Digital Avionics Systems Principles and Practice - R. Spitzer; The Blackburn Press.

4. Antennas and Wave propagation- 4th Edition, John D Kraus, Ronald J Marhefka; McGraw-Hill

5. Avionics Navigation Systems – Myron Kayton; Wiley-Interscience.

6. Elements of Electronic Navigation- N S Nagaraja; McGraw-Hill.

Course Title: Digital Signal Processing

Course Code: AEAV 6237

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: The primary objective of this Course is to provide a thorough understanding and working knowledge of design, implementation and analysis DSP systems.

Objective:

1. To make students familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors.
2. To make students aware about the meaning and implications of the properties of systems and signals.

Learning Outcomes (CO):

Upon completion of the Course, the students will be able to:

1. Use Concepts of trigonometry, Complex algebra, Fourier transform, z-transform to analyze the operations on signals and acquire knowledge about Systems
2. Select proper tools for analog-to-digital and digital-to-analog COnversion. Also select proper tools for time domain and frequency domain implementation.
3. Design, implementation, analysis and comparison of digital filters for processing of discrete time signals Integrate computer-based tools for engineering applications
4. Employ signal processing strategies at multidisciplinary team activities.
5. Assess the techniques, skills, and modern engineering tools necessary for analysis of different electrical signals and filtering out noise signals in engineering practice.

Course Contents:

Introduction to digital signal processing of COntinuous and discrete signals, The family of Fourier Transforms including the Discrete Fourier Transform (DFT), Development of the Fast Fourier Transform (FFT), Signal sampling and reConstruction, Design and analysis of digital filters, correlation and spectral estimation, Estimators of second order properties of random processes: nonparametric and model-based techniques of spectral estimation.

Teaching-learning Strategy : Lectures, class performances, assignments, class tests, final exam.
Assessment Strategy: As convenient by instructor.

Linkage of CO with Assessment Methods& their Weights: As convenient by instructor.

Mapping of Course CO and Program Outcomes (PO):

Learning Outcomes (COs) of this Course	**Program Outcomes (PO)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Use Concepts of trigonometry, Complex algebra, Fourier transform, z-transform to analyze the operations on signals and acquire knowledge about Systems.	√											
2. Select proper tools for analog-to-digital and digital-to-analog Conversion. Also select proper tools for time domain and frequency domain implementation.				√								

3. Design, implementation, analysis and comparison of digital filters for processing of discrete time signals integrate computer-based tools for engineering applications.								√				
4. Employ signal processing strategies at multidisciplinary team activities.			√									
5. Assess the techniques, skills, and modern engineering tools necessary for analysis of different electrical signals and filtering out noise signals in engineering practice.												√

Text and Ref Books:

1. Digital Signal Processing-A Computer based approach, S. Mitra, TMH
2. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis & M.G. Manslakis, PHI Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.
3. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learning.

Course Title: Detection and Estimation

Course Code: AEAV 6238

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: The primary objective of this Course is to provide e basic estimation and detection background for engineering applications. After taking this Course, students should have enough understanding of the main Concepts and algorithms of detection and estimation theory for practical applications as well as for their research.

Objective:

1. To enable the students to acquire the fundamental Concepts of Signal Detection and Estimation.
2. To get familiarize with different Hypotheses in detection and estimation problems.
3. To introduce the methods of Detection and estimation of signals in white and non-white Gaussian noise.
4. To familiarize with the detection of random signals.
5. To enable the students to understand the time varying waveform detection and its estimation.

Learning Outcomes (CO):

Upon completion of the Course, the students will be able to:

1. Construct a hypothesis testing problem; specify the probability distributions of the observations under each hypothesis; formulate optimal decision rules according to various criteria.
2. Apply the Bayesian, minimax or Neyman-Pearson approaches to design optimal decision rules; assess the Bayes risk, minimax risk, detection probability, and false-alarm probability.

3. Apply detection theory for signal detection in discrete time; design optimal receiver structures.
4. Construct a parameter estimation problem; specify the likelihood function; formulate optimal estimators according to various criteria.
5. Design Bayesian estimator in presence of prior information; design minimum variance unbiased estimator or maximum likelihood estimation in absence of prior information.

Course Contents:

Gauss-Markov processes and stochastic differential equations, Bayes estimation theory, maximum likelihood, linear minimum deviation, minimum-squares estimation, properties of estimators, error analysis, state prediction for linear systems, Kalman-Bucy and Wiener filters, leveling and pre-estimation methods, nonlinear estimation, filtering applications, Communications, control, system identification and biomedical engineering applications.

Teaching-learning Strategy : Lectures, class performances, assignments, class tests, final exam.
Assessment Strategy: As convenient by instructor.

Linkage of CO with Assessment Methods & their Weights: As convenient by instructor.

Mapping of Course CO and Program Outcomes (PO):

Learning Outcomes (COs) of this Course	**Program Outcomes (PO)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Construct a hypothesis testing problem; specify the probability distributions of the observations under each hypothesis; formulate optimal decision rules according to various criteria.		√										

2. Apply the Bayesian, minimax or Neyman-Pearson approaches to design optimal decision rules; assess the Bayes risk, minimax risk, detection probability, and false-alarm probability.			√									
3. Apply detection theory for signal detection in discrete time; design optimal receiver structures.	√											
4. Construct a parameter estimation problem; specify the likelihood function; formulate optimal estimators according to various criteria.				√								
5. Design Bayesian estimator in presence of prior information; design minimum variance unbiased estimator or maximum likelihood estimation in absence of prior information.			√									

Text and Ref Books:

1. An Introduction to Signal Detection and Estimation, H. Vincent Poor, 1994/2nd, Springer.
2. Linear Estimation Theory by Thomas Kailath
3. Detection Theory, Applications and Digital Signal Processing by Ralph D. Hippenstiel, CRC Press
4. Detection and Estimation Theory and its Applications by Thomas A. Schonhoff & Arthur A. Giaordane
5. An Introduction to Signal Detection and Estimation by H. Vincent Poor

6. Detection, Estimation and Modulation theory Part-I, Detection, Estimation and Linear Modulation Theory by Harry L. Van Trees, John Wiley Publishers

Course Title: Fault tolerant Avionics Design

Course Code: AEAV 6240

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: To analyse the criticality level of onboard hardware and software and assess the sources of error of various aircraft instruments and systems and the robustness of an avionic system or architecture and identify possible failure modes and bottlenecks.

Objective:

1. To describe the fundamental components of an avionic system;
2. To discuss avionic data buses;
3. To discuss avionic Computer architectures;
4. To introduce standards and guidelines for airborne hardware and software;
5. To discuss flight deck instrumentation and displays;
6. To discuss the functionality of various avionic systems that are typically found on modern aircraft;
7. To explain the techniques and processes associated with the identification of failure modes and the design of fault-tolerant avionic systems.

Learning Outcomes (CO):

Upon completion of the course, the students will be able to:

1. Highlight the benefits of digital avionic systems and identify their main components;
2. Explain the purpose and functionality of flight deck instrumentation and displays;
3. Describe the purpose and functionality of typical avionic systems;
4. Explain techniques to identify failure modes associated with avionic systems and to design fault-tolerant systems.

Course Contents:

Concepts of dependability, Fault, cause and effect, Hardware fault tolerance, Software fault tolerance, Failure detection techniques, Design of practical fault-tolerant avionics systems, Case study – Fault-tolerant navigation systems and flight control systems.

Teaching-learning Strategy: Lectures, class performances, assignments, class tests, final exam.
Assessment Strategy: As convenient by instructor.

Linkage of LO with Assessment Methods & their Weights: As convenient by instructor.

Mapping of LO and Program Outcomes (PO):

Learning Outcomes (LOs) of this Course	**Program Outcomes (PO)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. Highlight the benefits of digital avionic systems and identify their main Components.	√											
2. Explain the purpose and functionality of flight deck instrumentation and displays.					√							

3. Describe the purpose and functionality of typical avionic systems.					√							
4. Explain techniques to identify failure modes associated with avionic systems and to design fault-tolerant systems.				√								

Text and Ref Books:

1. Helfrick, A., Principles of Avionics, 9th Edition, 2015, Avionics Communications Inc.
2. Collinson, R.P.G., Introduction to Avionics Systems, 3rd Edition, 2011, Springer Netherlands.
3. Buckwalter, L., Avionics Databuses, 3rd Edition, 2005, Airline Avionics.
4. Stimson, G.W., Introduction to Airborne Radar, 3rd Edition, 2014, SciTech Publishing.
5. Moir, I., Seabridge, A., Jukes, M., Civil Avionics Sysems, 2nd Edition, 2013, Wiley.
6. Spitzer, C.R., Digital avionics handbook, 2nd Edition, 2007, CRC P.
7. Spitzer, C.R., Avionics : elements, software and functions, 2007.
8. Spitzer, C.R., Avionics : deveCOpment and implementation, 2006.

Course Title: Advanced Electromagnetic Field Theory

Course Code: AEAV 6241

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale:

To learn and familiarize with the basics of electro- magnetic field theories and implement that knowledge in the field of communication.

Objective:

1. To learn the basic of Static electric field
2. To study the different boundary conditions
3. To use the principles Poisson‘s and Laplace‘s equations in different co-ordinate systems.
4. To understand the basic of Maxwell‘s equations: Faraday‘s law of electromagnetic induction,

Learning Outcomes (LO)

Upon completion of the Course, the students will be able to:

1. Apply vector calculus to static electric-magnetic fields in different engineering situations.
2. Analyze Maxwell’s equation in different forms (differential and integral) and apply them to diverse engineering problems.
3. Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.
4. Analyze the nature of electromagnetic wave propagation in guided medium which are used in microwave applications.
5. Calculate electric and magnetic fields from stationary and dynamic charge and current distributions and solve simple electrostatics boundary problems**.**

Course Contents:

Vectors, Columb's law, Electric Field, Guass's Law, Scalar Potential, COnductors in Electrostatic Fields, Electrostatic Energy, Electric Multi-poles, Boundary conditions at Surface Discontinuity, Electrostatics in the presence of Matter, Special Methods in Electrostatics, Electric Currents, Ampere's Law ,Magnetic Induction, Integral form of ampere's law, Vector potential, Faraday's Law of Inductions, Magnetic Energy, Magnetic Multi-poles, magnetism in the presence of matter, Maxwell's Equations, and Scalar and vector Potentials.

Teaching-learning Strategy: Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by instructor.

Linkage of LO with Assessment Methods& their Weights: As convenient by instructor.

Mapping of Learning Outcomes and Program Outcomes:

Learning Outcomes (LO) of the Course	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Apply vector calculus to static electric-magnetic fields in different engineering situations.	√											
2. Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems.		√										
3. Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.				√								
4. Analyze the nature of electromagnetic wave propagation in guided medium which are used in microwave applications.				√								
5. Calculate electric and magnetic fields from stationary and dynamic charge and current distributions and solve simple electrostatics boundary problems**.**			√									

Text and Ref Books:

1. Engineering Electromagnetics – W. H. HaytJr& John A. Buck; Tata McGraw-Hill Publishing Company Ltd
2. Fields and Waves in Communication Electronics - Simon Ramo; John Wiley & Sons.
3. Fundamentals of Engineering Electromagnetic - D.K. Cheng; Prentice Hall of India Private Ltd.

Course Title: Advanced Radar Engineering

Course Code: AEAV 6242

Level: Post-graduation program

Credit Hour: 3.00

Contact Hour: 3.00 (per week)

Rationale:

This course is an introduction to radar. It is designed to develop the knowledge and techniques necessary to analyze the performance of radar systems so that ultimately, the student is able to specify the subsystem performance requirements in a radar system design.

Course Contents:

Advanced radar techniques and specialist radar applications, Distributed Radar sensing, Netted Radar, MIMO, Passive Radar, Bio-Inspired Sensing, Waveform diversity, Micro-doppler, Target classification, Cognitive sensing, Adaption and feedback, Resource management, Perception and action, Navigation and collision avoidance, Processing architectures.

Objective:

1. To explain the principle involved in radar system
2. To know the various types of radar and areas of applications
3. To compute radar parameters
4. To solve problems relating to radar

Learning Outcomes:

Upon completion of the course, the students will be able to:

1. Describe theoretical principles of different equipment of RADAR system.
2. Apply basic radar knowledge in handling different radar system in aircraft communication and navigation both in peacetime and wartime scenario.
3. Design and develop basic radar system to contribute the development of society.

4. Analyze and evaluate the performances of different antenna and different radar systems in detection, tracking, weather updates, jamming and electronic counter measures.

Teaching-learning Strategy:

Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by the instructor.

Linkage of LO with Assessment Methods & their Weights:

As convenient by the instructor.

Mapping of Learning Outcomes (LO)and Program Outcomes:

Learning Outcomes (LOs) of this course	**Program Outcomes**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.Describe theoretical principles of different equipment of RADAR system.	✓											
2.Apply basic radar knowledge in handling different radar system in aircraft communication and navigation both in peacetime and wartime scenario.	✓											
3.Design and develop basic radar system to contribute the development of society.			✓									
4.Analyze and evaluate the performances of different antenna and different radar systems in detection, tracking, weather updates, jamming and electronic counter measures.		✓										

Text and Ref Books:

1. Sklonik Merrill,"Introduction To Radar Systems", Tata McGraw-Hill, 3rd Ed., 2001.
2. Nagaraja N. S.,"Elements Of Electronics Navigation", Tata McGraw-Hill, 2nd Ed.,1996.
3. Sharma K. K.,"Radar, Sonar And Navigation Engineering", S K Kataria & Sons, 2nd Ed., 2006.
4. Mitra Monojit,"Microwave Engineering", Dhanpat Rai & Co., 3rd Ed., 2006.
5. Kennedy George and Davis Bernard,"Electronics Communication Systems", Tata McGraw-Hill, 4th Ed., 1999.

Course Title: Transmission Line and Waveguides

Course Code: AEAV 6244

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale:

To learn about Transmission Lines and their application in EM wave propagation.

Learning Outcomes (LO)

Upon completion of the Course, the students will be able to:

1. Explain the propagation characteristics of electromagnetic waves in transmission lines.
2. Analyze & design various transmission line components & circuits.
3. Analyze the propagation characteristics of electromagnetic waves in various wave guide structures.
4. Explain Microstrip Line and its characteristics.

Course Contents:

Smith chart and its applications in Impedance matching characteristics of EM wave propagation in Parallel plate, Rectangular, Circular and Cavity resonators ,the concept of Microstrip Line.

Teaching-learning Strategy: Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by instructor.

Linkage of LO with Assessment Methods& their Weights: As convenient by instructor.

Mapping of Learning Outcomes and Program Outcomes:

Course Outcome (CO) of the Course	**Program Outcomes* (Appendix-1)**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Explain the propagation characteristics of electromagnetic waves in transmission line.	√						√					√
2. Analyze & design various transmission line components & circuits.	√						√					
3. Analyze electromagnetic waves in various wave guide structures.	√	√					√					
4. Explain Microstrip Line and its characteristics		√										

Text and Ref Books:

1. Engineering Electromagnetics – W. H. HaytJr& John A. Buck; Tata McGraw-Hill Publishing Company Ltd

2. Fields and Waves in Communication Electronics - Simon Ramo; John Wiley & Sons.

3. Fundamentals of Engineering Electromagnetic - D.K. Cheng; Prentice Hall of India Private Ltd.

Course Title: Advanced Wireless Communications

Course Code: AEAV 6245

Level: Post-graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale:

To learn and analyze Advanced Wireless Communications.

Learning Outcomes (LO)

Upon completion of the Course, the students will be able to:

1. Explain fundamentals of mobile wireless channels, and the limitations of mobile channels imposed on communication systems
2. Analyze the architectures of mobile communications, and recent standard mobile systems, such as the fourth generation (4G) system
3. Analyze the foundation of understanding and working for future generation of wireless systems

Course Contents:

Mobile fundaments - Multiple access techniques: frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA), space division multiple access (SDMA) - Space-time processing: multiple antenna techniques, diversity and multiplexing gains, multiple-input multiple-output (MIMO) systems. Mobile radio channels - Pathloss, large-scale fading, small-scale fading; Power budge of mobile links - Doppler spread and coherent time, delay spread and coherent bandwith; flat fading and frequency selective fading. Modulation and transmission - Digital modulation overview and digital modulation schemes, spectral efficiency and implementation complexity, power efficiency and green communication - Carrier and clock recovery, coherent receiver and non-coherent receiver - Adaptive signal processing for communication, channel equalisation, combating interference, and multi-user detection - Multi-carrier orthogonal frequency division multiplexing (OFDM) and single-carrier block transmission with frequency domain equalisation. Practical channel coding schemes - The fundamentals of forward error correction (FEC) coding, convolutional coding, linear block coding, hard-decision channel decoding, soft-decision channel decoding - Turbo principle, turbo coding, turbo decoding-

detection, near-capacity three-stage concatenated turbo transceiver. MIMO technology - The fundamentals of MIMO, diversity and multiplexing gains, beamforming gain, SDMA based multi user system - Vertical Bell Lab layered space-time (V-BLAST), space-time block codes (STBCs), Linear dispersion codes (LDCs), spatial modulation (SM) and space-shift keying (SSK), and spacetime shift keying (STSK) - A unified MIMO - Acquisition of MIMO channel state information (CSI), state-of-the-art near-capacity MIMO systems. Existing and future wireless systems and standards - 1st generation (1G) system, 2G system, 3G system, and 4G system. - Beyond 4G (B4G) system, massive MIMO, millimeter wave communication, optical wireless.

Teaching-learning Strategy: Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by instructor.

Linkage of LO with Assessment Methods& their Weights: As convenient by instructor.

Mapping of Learning Outcomes and Program Outcomes:

Course Outcome (CO) of the Course	**Program Outcomes* (Appendix-1)**											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Explain fundamentals of mobile wireless channels, and the limitations of mobile channels imposed on communication systems	√											
2. Analyze the architectures of mobile communications, and recent standard mobile systems, such as the fourth generation (4G) system							√					
3. Analyze the foundation of understanding and working for future generation of wireless systems		√										

Text and Ref Books:

1. Engineering Electromagnetics – W. H. HaytJr& John A. Buck; Tata McGraw-Hill Publishing Company Ltd

2. Fields and Waves in Communication Electronics - Simon Ramo; John Wiley & Sons.

3. Fundamentals of Engineering Electromagnetic - D.K. Cheng; Prentice Hall of India Private Ltd.

Course Title: Microwave Devices and Circuits Design

Course Code: AEAV 6243

Level: Post graduation program

Credit Hour: 3.0

Contact Hour: 3.0

Rationale: To learn about performance of microwave devices and developing equations.

Course Synopsis:

An introduction to microwave engineering ,Transmission lines as circuit elements, Smith chart analysis methods , Impedance transforming and matching circuits , Line and waveguide structures and associated components ,Power waves and the network scattering matrix , Passive devices ,Two-port network signal transmission , Active devices , Communication link design.

Learning Outcomes:

1. Explain RF/microwave analysis methods and design techniques.
2. Analyze devices and system behavior.
3. Explain Design procedures along with methods to evaluate device performance.

Teaching-learning Strategy: Lectures, class performances, assignments, class tests, final exam.

Assessment Strategy: As convenient by instructor

Linkage of CO with Assessment Methods& their Weights: As convenient by instructor

Mapping of Course Outcomes and Program Outcomes:

Course Outcome (CO) of the Course	Program Outcomes* (Appendix-1)											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Explain RF/microwave analysis methods and design techniques.	√											
2.Analyze devices and system behavior			√									
3. Explain Design procedures along with methods to evaluate device performance.	√											

Books Recommended: Microwave Engineering: Ernest Bridges