Detailed Syllabus

Bachelors of **Aerospace Engineering**

Department of Mechanical Engineering

Institute of Engineering

Pulchowk Campus

Tribhuvan University

Submitted by

Department of Mechanical Engineering/ (Aeronautical Faculties)

Pulchowk Campus

Date: 31/02/2075

A
Report
on
Conducting Bachelor of Engineering in Aerospace Engineering at Pulchwok Campus, Institute of Engineering, Tribhuvan University, Nepal

Submitted by:

Aeronautical Faculties

Submitted to:
Institute of Engineering, Tribhuvan University, Nepal

June 14, 2018

Prepared by the study committee for

Conducting Bachelor of Engineering in Aerospace Engineering at Pulchwok Campus, Institute of Engineering, Tribhuvan University, Nepal

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1. Introduction

The report summarizes the study conducted by a committee at Department of Mechanical Engineering, Institute of Engineering, related to the requirements and feasibility of starting an aerospace faculty under the department. A study of syllabi for Aerospace engineering from foreign universities was collected and a generic syllabus was created, which is provided in this report. Based on the generic syllabus, the requirements for the faculty were outlined and the necessary laboratories were identified.

The prospects of starting an Aerospace faculty were analyzed through a discussion with stakeholders containing experts from various aviation-related sectors as well as IOE faculty members. The suggestions from the panel were collected and further discussed to find a conclusion about the external prospects and market interests that the faculty can hold.

The study finds that with proper infrastructural and financial resources at place it is possible to start the major in Aerospace engineering. Detailed course outline has been purposed for this program.

1.1 Background

At present, elective courses in Aerospace engineering are offered to fourth-year B.E. students from Mechanical Engineering stream. Three courses are offered for a period of two semesters- one course in 7th semester and the remaining two in 8th Semester. The courses offered are:

- Basic Aircraft and Airframe
- Aircraft Dynamics
- Avionics

Participation of the students for these elective courses has been very inspiring. Yearly number of students go abroad to pursue Bachelor's degree in Aerospace Engineering.

Currently we IOE Pulchowk, TU has been working on developing/establishing Aerospace lab consisting of aerospace parts. With the collaboration of Nepal Airline number of airframe, engine and avionic parts of the old aircrafts have been brought to the university laboratory.

The committee was formed with various objectives (section 1.2 of this report) on date November 30, 2017 by the Dean of the Institute of Engineering. Members of committee were:

Mr. Rudra Mani Ghimire, Assistant Professor, Dy Head, Department of Mechanical Engineering, IOE-Pulchowk	- Coordinator
Dr. Ajay Kumar Jha, Assistant Professor, Department of Mechanical Engineering, IOE-Pulchowk	- Member
Mr. Hari Bahadur Dura, Assistant Professor, Department of Mechanical Engineering, IOE-Pulchowk	- Member
Dr. Udayakrishna Shrestha, Buddha Air, Nepal	- Member
Ms. KalpanaPaudel, Section Officer, Office of Dean, Institute of Engineering	- Member Secretary

The work of the committee was based on the report *"Aerospace Engineering Feasibility Status - A Report on the Feasibility Status for Starting an Aerospace Faculty under IOE"* (August 26, 2014, Institute of

Engineering), which was prepared by an earlier committee to create a road map for the development of an Aerospace Engineering faculty at IOE.

1.2 Objectives

The objectives of this committee can be summarized in following points:

- To conduct study on national relevancy of Bachelors of Engineering in Aerospace Engineering
- To study the sustainability and infrastructures the Bachelor of Engineering in Aerospace Engineering.
- To prepare course outline and syllabus outline of Bachelor of Engineering in Aerospace Engineering.
- To conduct discussion programs with the stakeholders.
- To carry out financial and sustainability analysis of this program.

1.3 Relevance of Program

Relevance of the Bachelor of Engineering in Aerospace Engineering can be summarized from various aspects such as domestic airlines, defense, and space exploration to research and cutting edge technological development of various sector.

1.3.1 Strengthen Nepalese Aviation

The technical manpower produced from this program will be great asset for many fast growing Nepalese airlines. As Nepal is expanding rapidly in the field of aviation (number of international airports are under construction and Nepalese Airlines are increasing their fleet every year) will obviously need more engineers. Looking at the history of the Nepal Airlines Corporation (NAC), Buddha Air, Himalayan Airlines and many others airlines, it is evident that Nepalese aviation industry will need hundreds of Aerospace Engineers in next decade. Engineers taught and trained in the country will be of great value for the economic value. Programs and training that the future graduates will achieve will help them to blend easily with the national aviation market. Future Aerospace graduates of this institute easily blend and partially fulfill the need of national aviation market.

1.3.2 Future of Defense and Aerospace

Aerospace engineering has been always been closely linked to defense and national pride. Exploration of space is far fact for Nepal but the country can specialize and contribute in certain specific areas of defense and aerospace.

- Aerospace Engineers taught and trained in the country will can strengthen the aviation industry of the country. As Nepal is expanding rapidly in the field of aviation (number of international airports are under construction and Nepalese Airlines are increasing their fleet every year) will obviously need more engineers. Programs and training that the future graduates will achieve will help them to blend easily with the national aviation market.
- Aerospace program can help to design and fabricate modern agricultural airplanes at home. Also they can be used for search and rescue mission of those people who go missing in high Himalayas every year.
- Defense Industry of Israel accounts for 10% of the world total in 2007.
- Many Unmanned Aerial Vehicle startups are growing fast in countries like Korea, India, Israel and Argentina. Nepal can take benefit of such market.
- The companies like Boeing and Airbus imports various aircraft components from number of countries. In long run Nepal can contribute on such profitable market.

- With the help of future researchers at Aerospace/Aerospace department Nepal can develop their own homemade air defense vehicles.
- The yearly defense industry budget of the world accounts more than a trillion dollar, in which American, European, Israel, Japan, Korean are major player.

1.3.3 Students studying abroad

Many students go abroad to pursue undergraduate and graduate degree in Aerospace/Aerospace Engineering. In many countries where English is not spoken language, Nepalese students face several problems in dealing with facilities. The program will help to realize the dream of pursuing higher studies in field of Aeronautics within country and hence save significant amount of outgoing money.

Table 1-1Undergraduate Tuition Fees Abroad

<table>
<tr><th>Country</th><th>Number of Nepalese Students</th><th>Annual Fees (Sept. 2015)</th></tr>
<tr><td>China</td><td>~50</td><td>3,60,000/-</td></tr>
<tr><td>India</td><td>~30</td><td>3,20,000/-</td></tr>
<tr><td rowspan="2">United Kingdom</td><td rowspan="2">~5</td><td>29,28,000/- (international)</td></tr>
<tr><td>14,64,000/- (home)</td></tr>
<tr><td rowspan="3">United States of America</td><td rowspan="3">1</td><td>42,14,000/-</td></tr>
<tr><td>11,59,000/- (in-state)</td></tr>
<tr><td>27,39,000/- (out-of-state)</td></tr>
</table>

Table 1-2Postgraduate Tuition Fees Abroad

Country	Number of Nepalese Students	Remarks
China	~30	Scholarships offered.
India	~10	Approximate number.
S. Korea	~6	At KIAST and Seoul National University
European Union	N/A	Students predictably high in number
United States of America	N/A	Predictably high, mostly supported by stipend, grants and scholarships

2. Courses of Bachelor of Aerospace Engineering

After discussion with many stakeholders and intellects from various universities, companies and research agencies. A generic syllabus for aerospace engineering is presented in this chapter. Major focus has been given in design and analysis of aerospace vehicles. The course also includes ethical courses to teach the students about the human norms and values. The study steam has valued the suggestions comments and national need for advanced research and development works.

The graduates of this course will have skills to work in various cutting edge technological industries. The program aims to teach students with advanced analysis and design tools like computational fluid dynamics, computational mechanics and experimental techniques.

2.1 Course Summary

Graduates of the Aerospace engineers will be equipped with sound technical and ethical knowledge for the development of the aerospace field in country and abroad. The graduates will have an opportunity to select elective courses specializing in:

- Aircraft Design (Structural and Aerodynamic Design)
- Aircraft Maintenance Engineering
- Aerospace Fluid Mechanics/propulsion
- Material Science and Manufacturing Process
- Avionics and Aircraft Navigation.

Notably the Bachelors of Aerospace program will strengthen knowledge on Humanities, Arts and Basic Science, Design, Production Management and Engineering Science.

2.2 Course Outline

From the previous studies on the feasibility of the program and suggestions of many intellects and professionals, a draft has been prepared as the course outline for the Bachelor of Aerospace Program. The study team has finally come to the final course outline in the form of Table 2-1. The distribution of the courses includes from Humanities, Arts, Science, Mechanical Engineering and Aerospace Engineering. First Year is majority dominated by courses from Science and Mechanical Engineering. Courses of the 2nd year are dominated by mechanical engineering. While the third and fourth year are core Aerospace Engineering courses.

Many developing countries are currently working in the areas of Unmanned Air Vehicles (UAVs) for various purposes. The second part of 3rd year (i.e. 6th Semester) of this program will have this course specifically to teach the students the fundamentals of UAVs design. UAVs can be used in Modern Agriculture/Farming, Weather forecast, surveillance, search-rescue missions in high Himalayas.

The proposed course outline for the Bachelors of Aerospace Engineering are as follows:

Table 2-1Course outline for Bachelor of Aerospace Engineering

Year I															Part: I
Teaching Schedule							Examination Scheme								
							Theory			Practical					
							Assessment Marks	Final		Assessment Marks	Final				
S.No.	Course Code	Course Title	L	T	P	Total		Duration Hrs	Marks		Duration Hrs	Marks	Total	Remarks
1	SH 401	Engineering Mathematics - I	3	2	0	5	20	3	80				100	
2	SH 452	Engineering Physics	4	1	2	7	20	3	80	20	3	30	150	
3	EE 451	Basic Electrical Engineering	3	1	1.5	5.5	20	3	80	25			125	
4	CE 451	Applied Mechanics	3	2	0	5	20	3	80				100	
5	ME 401	Engineering Drawing - I	1	0	3	4				60	3	40	100	
6	ME 403	Workshop Technology	1	0	3	4	10			40			50	
		Total	**15**	**6**	**9.5**	**30.5**	**90**	**12**	**320**	**145**	**6**	**70**	**625**	

Year I														Part: II
Teaching Schedule							Examination Scheme							
							Theory			Practical				
							Assessment Marks	Final		Assessment Marks	Final			
S.No.	Course Code	Course Title	L	T	P	Total		Duration Hrs	Marks		Duration Hrs	Marks	Total	Remarks
1	SH 451	Engineering Mathematics - II	3	2	0	5	20	3	80				100	
2	ME 451	Engineering Drawing- II	1	0	3	4				60	3	40	100	
3	EX 451	Basic Electronics Engineering	3	1	1.5	5.5	20	3	80	25			125	
4	CT 401	Computer Programming	3	0	3	6	20	3	80	50			150	
5	SH 403	Engineering Chemistry	3	1	3	7	20	3	80	20	3	30	150	
6	ME 402	Fundamentals of Thermodynamics and Heat Transfer	3	1	1.5	5.5	20	3	80	25			125	
		Total	**16**	**5**	**12**	**33**	**100**	**15**	**400**	**180**	**6**	**70**	**750**	

Year: II — Part: I

Teaching Schedule							Examination Scheme						Total	Remarks
							Theory			Practical				
								Final			Final			
S.No.	Course Code	Course Title	L	T	P	Total	Assessment Marks	Duration Hrs	Marks	Assessment Marks	Duration Hrs	Marks		
1	SH 501	Engineering Mathematics - III	3	2	0	5	20	3	80				100	
2	AE	Fundamentals of Aerospace Engineering	3	0	1.5	4.5	20	3	80				100	
3	ME 502	Engineering Mechanics	3	1	0	4	20	3	80				100	
4	ME 554	Fluid Mechanics	3	1	1.5	5.5	20	3	80	25			125	
5	AE	Applied Thermodynamics and Heat Transfer	3	1	1.5	5.5	20	3	80	25			125	
6	AE	Computer Aided Design and Manufacturing	3	1	1.5	5.5	20		80	25			125	
		Total	**18**	**6**	**6**	**30**	**120**	**15**	**480**	**75**			**675**	

Year: II — Part: II

Teaching Schedule							Examination Scheme						Total	Remarks
							Theory			Practical				
								Final			Final			
S.No.	Course Code	Course Title	L	T	P	Total	Assessment Marks	Duration Hrs	Marks	Assessment Marks	Duration Hrs	Marks		
1	SH 552	Probability and Statistics	3	1	0	4	20	3	80				100	
2	EE 602	Control Systems	3	1	1.5	5.5	20	3	80	25			125	
3	AE	Aerospace Materials	4	0	1.5	5.5	20	3	80	25			125	
4	AE	Aerodynamics	3	2	1.5	6.5	20	3	80	25			125	
5	ME 552	Strength of Materials	3	1	1.5	5.5	20	3	80	25			125	
6	ME 653	Theory of Mechanism and Machine I	3	1.5	0	4.5	20	3	80				100	
		Total	**19**	**6.5**	**6**	**31.5**	**120**	**18**	**480**	**100**			**700**	

Year: III														Part: I
Teaching Schedule							Examination Scheme						Total	Remarks
							Theory			Practical				
								Final			Final			
S.No.	Course Code	Course Title	L	T	P	Total	Assessment Marks	Duration Hrs	Marks	Assessment Marks	Duration Hrs	Marks		
1	SH 603	Numerical Methods	3	1	3	7	20	3	80	50			150	
2	AE	Aircraft Manufacturing Process	3	0	2	5	20	3	80	50			150	
3	AE	Theory of Vibration	3	1	1.5	5.5	20	3	80	25			125	
4	AE	Continuum Mechanics	3	1	1.5	5.5	20	3	80	25			125	
5	AE	Aircraft Propulsion	4	0	1.5	5.5	20	3	80	25			125	
6	AE	Fault Monitoring and Diagnosis	3	1	1.5	5.5	20	3	80	25			125	
		Total	**19**	**4**	**11**	**34**	**120**	**18**	**480**	**200**			**800**	

Year: III														Part: II
Teaching Schedule							Examination Scheme						Total	Remarks
							Theory			Practical				
								Final			Final			
S.No.	Course Code	Course Title	L	T	P	Total	Assessment Marks	Duration Hrs	Marks	Assessment Marks	Duration Hrs	Marks		
1	AE	Avionics	3	1	1.5	5.5	20	3	80	25			125	
2	AE	Aircraft Maintenance Engineering	4	0	1.5	5.5	20	3	80	50			150	
3	ME 751	Finite Element Method	3	1	1.5	5.5	20	3	80	25			125	
4	AE	Aircraft Environment Control System	3	1	1.5	5.5	20	3	80	25			125	
5	AE	Flight Dynamics	3	1	1.5	5.5	20	3	80	25			125	
6	AE	Unmanned Air Vehicle Synthesis	3	1	1.5	5.5	20	3	80	25			125	
		Total	**19**	**5**	**9**	**33**	**120**	**18**	**480**	**175**			**775**	

Year: IV														Part: I
Teaching Schedule							Examination Scheme						Total	Remarks
							Theory			Practical				
								Final			Final			
S.No.	Course Code	Course Title	L	T	P	Total	Assessment Marks	Duration Hrs	Marks	Assessment Marks	Duration Hrs	Marks		
1	AE	Aircraft Preliminary Design	3	1	1.5	5.5	20	3	80	25			125	
2	AE	Computational Fluid Dynamics	3	1	1.5	5.5	20	3	80	25			125	
3	AE	Air Traffic Management	4	0	1.5	5.5	20	3	80	25			125	
4	AE	Aircraft Structures	3	1	1.5	5.5	20	3	80	25			125	
5	AE	Embedded Systems in Avionics	3	1	2	4	20	3	80				100	
6	AE	Elective I	3	1	1.5	5.5	20	3	80	25			125	
7	AE	Project I								50			50	
		Total	**19**	**5**	**9.5**	**31.5**	**120**	**18**	**480**	**150**			**775**	

Year: IV														Part: II
Teaching Schedule							Examination Scheme						Total	Remarks
							Theory			Practical				
								Final			Final			
S.No.	Course Code	Course Title	L	T	P	Total	Assessment Marks	Duration Hrs	Marks	Assessment Marks	Duration Hrs	Marks		
1	AE	Internship	0	0	6	6				100		100	200	
2	AE	Aviation Professional Practices	2	0	0	2	10	1.5		40			50	
3	AE	Elective II	3	1	1.5	5.5	20	3	80	25			125	
4	AE	Elective III	3	1	1.5	5.5	20	3	80	25			125	
5	AE	Project II	0	0	6	6				100		75	175	
		Total	**8**	**2**	**15**	**25**	**50**	**7.5**	**160**	**290**		**175**	**675**	
Note: Industrial attachment includes internship at Airlines or design analysis companies (CAE) not only limited to aviation industry.														

Elective courses as per specialization course:

Stream: Aerodynamics & Propulsion				
S.No.	**Course Code**	**Elective**	**Course Title**	**Remarks**
1	AE	Elective I	Unsteady Aerodynamics	
2	AE	Elective II	Rocket Propulsion	
3	AE	Elective III	Advanced Space Propulsion	

Stream: Aircraft Maintenance Engineering				
S.No.	**Course Code**	**Elective**	**Course Title**	**Remarks**
1	AE	Elective I	Aviation Legislation	
2	AE	Elective II	Human Reliability, Error and Factor in Aviation	
3	AE	Elective III	Fleet Planning for Airlines	

Stream: Structural Design				
S.No.	**Course Code**	**Elective**	**Course Title**	**Remarks**
1	AE	Elective I	Advanced Vibration	
2	AE	Elective II	Fatigue and Fracture Mechanics	
3	AE	Elective III	Non-destructive Testing	

Stream: Navigation/Avionics				
S.No.	**Course Code**	**Elective**	**Course Title**	**Remarks**
1	AE	Elective I	Digital Signal Processing	
2	AE	Elective II	Radar Communication	
3	AE	Elective III	Design of UAV avionics	

The details of working hours of the Aerospace program is given in Appendix A. Summary of the course hours of the program are as follows:

Table 2-2Total Class Hours per Semester

S.No.	Year.PART	Total Class Hours	Total Lecture Hours [Credit]	Remarks
1	1.1	113	15	Including work hour for lecture and practical classes/laboratories.
2	1.2		16	
3	2.1	103	18	
4	2.2		19	
5	3.1	120	19	
6	3.2		19	
7	4.1	98.5	19	Including work hour for lecture and practical classes/laboratories and assumed two elective streams run parallel (For example Aerodynamics and Maintenance Engineering) [See tables above]
8	4.2		8	
Total Class Hour		**520.2** [Including 20% overhead]	**133**	

2.3 Program Highlights

Bachelor's degree in Aerospace engineering will focus on advanced engineering design. The graduates of this program will be able to work in the companies which demands advanced design analysis techniques and software. The students will be equally competitive in the field of aviation design and manufacturing. They will have confidence in aviation/aerospace entrepreneur industries. Based on the areas of priorities, the Bachelor of Aerospace Engineering focuses on the following areas:

Focus areas:

- Aircraft Design (Aerodynamic Design and Structural Design)
- Aircraft Maintenance Engineering
- Material and Manufacturing Process in Aeronautics
- Aircraft/Aerospace Propulsion System
- Avionics (Communication Systems)

2.4 Strengthening Fundamentals

Fundamental courses of engineering and basic science are most for the undergraduate degree. The following sub-sections are the major areas of learning process in Bachelors of Aerospace engineering degree. Below provided sub-sections gives detail of core courses taught in this program. Electives courses are not included, as it can vary with number of student interest in specialization courses.

2.4.1 Aerospace Engineering

Table below provides the courses provided in focus to Aerospace engineering. It comprises courses in structural, fluid, thermal and electronics and control design.

Semester	Core Courses	No. of Subjects
1st		
2nd		
3rd	Fundamentals of Aerospace Engineering, Aircraft Materials and CAD/CAM	3
4th	Aerodynamics and Measurement Techniques	2
5th	Aircraft Manufacturing Process, Composite Materials, Aircraft Propulsion and Aircraft Maintenance Engineering	4
6th	Avionics, Fault Monitoring and Diagnosis, Finite Element Methods, Aircraft Environment Control System, Flight Dynamics, UAV Synthesis	6
7th	Aircraft Preliminary Design, Computational Fluid Dynamics, Aviation Economics and Management, Aircraft Structures and Embedded System in Avionics	5

The curses such as UAV system will teach students the details of design principles and requirements for the aircrafts. Students who wants to pursue courses in aircraft maintenance will have adequate courses for maintenance and those who wants to pursue for design will also have skills in design of UAV aircrafts. Not limited to UAV design, the graduates will also have deep understanding of commercial aircraft design practices.

2.4.2 Applied Mathematics

Fundamentals of mathematics is basis for all engineering students. The first six courses inMathematics given in table below deals with the knowledge of fundamentals. While courses in Finite Element Methods and Computational Fluid Dynamics provides students with skills software to use those mathematics in Engineering problems such as structural analysis, fluid dynamics analysis, thermal analysis or coupled problems.

Semester	Courses	No. of Subjects
1st	Engineering Mathematics – I	1
2nd	Engineering Mathematics – II	1
3rd	Engineering Mathematics – III	1
4th	Probability and Statics	1
5th	Numerical Methods	1
6th	Finite Element Methods	1
7th	Computational Fluid Dynamics	1

2.4.3 Structural and Mechanical Design

Structural designs are important part of any engineering analysis as they represent the final product that can be feel or touched. Hence design of structurally sound engineering components is most for Aerospace Engineering. On top of every land based structural designs, components used in aeronautics need to be light weight and very reliable. Courses in the following table will train the future Aerospace graduates to design efficient and reliable components. Among them courses such as Continuum Mechanics, Composite materials, finite element method and aircraft structures will teach the students with research capabilities in aerospace engineering.

Semester	Courses	No. of Subjects
1st	Applied Mechanics and Engineering Drawing	2
2nd	Engineering Drawing	1
3rd	Engineering Mechanics	1
4th	Strength of Materials and Theory of Machines and Mechanism	2
5th	Continuum Mechanics	2
6th	Finite Element Methods	1
7th	Aircraft Structures	1

Not only this, these structures have to undergo wide range of operational stresses and temperature field. These structures need to have fail safe design and design for high and low cycle fatigue stresses. Optimal design of various components is most important for the future graduates in Aerospace engineering.

2.4.4 Fluid and Thermal Design

Fluid or Aerodynamic design of an aircraft is most crucial component. With better aerodynamic design better efficiency can be achieved. Also the aircraft can save tons of fuel by improving aerodynamics. And at high speed, the structural components of an aircraft have to endure high temperature because of the skin friction. For supersonic flight, the temperature can go very high while for low subsonic commercial flights ambient temperature can go below -50ºC. For both high and very low temperature, behavior of air molecules are not unique and hence coupled aero-thermal problems exists. Graduates of Aerospace engineering students should be able to address such issues.

Semester	Courses	No. of Subjects
1st		
2nd	Fundamentals of Thermodynamics and Heat Transfer	1
3rd	Applied Thermodynamics and Fluid Mechanics	2
4th	Heat Transfer and Aerodynamics	2
5th	Numerical Methods	1
6th	Flight Dynamics	1
7th	Computational Fluid Dynamics	1

The fluid-thermal-structural is most complex and highly coupled problems evident in the field of aerospace engineering.

3. Infrastructures

3.1 Human Resources

Human resource required to run Aerospace Engineering requires academic faculties and administrative personals. The details of the faculties and administrative staffs required are mentioned in following subsection.

3.1.1 Faculties

Out of the new courses lsited above, several courses can be combined under a single faculty, to be taught by a single faculty member. As seen on the course outline (Table 2-1), many course are taught by mechanical and Aerospace engineering. Hence, faculties with both the background are necessary for the new program. Besides that the program will also need faculties from arts and science. Table 3-1 shows the detailed of faculties required for the new program.

Table 3-1 Number of Academic Faculties Required

S.No.	Particular	No. of Position	Work Load Per Year	Remarks (Minimum Requirement)
1	Professor of Aerospace Engineering	1	12	With BE in Aerospace/ Aeronautical Engineering and Masers/PhD in relevant field
2	Associate Professor of Aerospace Engineering	2	40	With BE in Aerospace/ Aeronautical Engineering and Masers/PhD in relevant field
3	Assistant Professor of Aerospace Engineering	6	180	With BE in Aerospace/ Aeronautical Engineering and Masers/PhD in relevant field
4	Professor of Mechanical Engineering	1	12	BE in Mechanical/ Aerospace/ Aeronautical Engineering and Masers/PhD in relevant field
5	Associate Professor of Mechanical Engineering	2	40	BE in Mechanical/ Aerospace/ Aeronautical Engineering and Masers/PhD in relevant field
6	Assistant Professor of Mechanical Engineering	4	120	BE in Mechanical/ Aerospace/ Aeronautical Engineering and Masers/PhD in relevant field
7	Instructor	1	30	BE in Aerospace/Aeronautical/Mechanical
8	Assistant Technician	5	86.2	BE in Aerospace/Aeronautical/Mechanical
	Total	**22**	**520.2**	
Note: Assistant Technicians will assist Course Laboratories and also maintain future laboratories under the program.				

3.1.2 Laboratory Technician

The Assistant Technicians mentioned in the Table 3-1 will be responsible for the 5 laboratories of Aerospace Laboratories. Table 3-2 gives the detailed allocation.

Table 3-2 Number of Assistant Technicians

S.No.	Particulars	No. of Staffs	Remarks
1	Aircraft Manufacturing Technology Laboratory	1	Each staffs for the mentioned laboratories need special skills.
2	Aircraft Structure Laboratory	1	
3	Aerospace propulsion Laboratory	1	
4	Fault Monitoring and Diagnosis	1	
5	Environment Control System Laboratory	1	
	No. of Assistant Technicians	5	

3.1.3 Administrative and Management Staffs

Table 3-3 gives the minimum number of staffs required to run the program. The estimated number of faculties are for the department with teaching purpose. For advanced research laboratories number of faculties and other staff required will depend on the nature of lab facilities, ongoing research activities and development laboratories.

Table 3-3 Administrative and Management Staffs

S.No.	Particulars	No. of Staffs	Remarks
1	Administrative Staff	2	The number of staffs can vary according to the location of each rooms/classes.
2	Store Keeper	1	
3	Peon	2	
4	Cleaning Staff	1	
5	Asst. Accountant	1	
	No. of Administrative and Management Staffs	7	

3.2 Physical Infrastructure

Well managed infrastructures and space are most important part of any educational program. To run a program, enough space for laboratories, classrooms and other ammenities are most. Following section gives the detaield information required to run Bachelor of Aerospace Program at IOE Pulchwok, TU, Nepal.

3.2.1 Office and Classrooms

Table 3-4 gives brief summary of space required to run Bachelor of Aerospace Engineering program. The construction of the building and infrastructures should be aesthetically beautiful and easily accessible. Some of these room will need partations as per the need of human resource and infrastructural management.

Table 3-4 Office and Classroom Details

S.No.	Particulars	Room			Remarks
		No.	Area (ft²)	Cost (@Rs. 3000/ sq. ft)	
1	Classroom	8	24 x 30	21,60,000	The cost may vary as per the dynamics of the market value. Also depends on the design and architecture of the building/rooms.
2	Administrative Office	2	15 x 12	5,40,000	
3	Teacher Office	3	24 x 30	21,60,000	
4	Project Hall	1	24 x 30	21,60,000	
5	Tea Room	1	24 x 15	10,80,000	
6	Conference Hall	1	24 x 30	21,60,000	
7	Toilet/Bathroom	3	15 x 12	5,40,000	
8	Store Room	2	15 x 12	5,40,000	
	Sub-Total			**1,13,40,000**	
Note: The above cost doesn't include the cost for furniture and classroom amenities.					

3.2.2 Laboratory Requirements

Bachelors of Aerospace Engineering will have some common courses and laboratories with the Bachelors of Mechanical Engineering at IOE, Pulchowk TU. Besides the current mechanical laboratories, Aerospace Engineering will have other five important laboratories that are required to be installed. Table 3-5 gives list of these laboratories required while Table 3-6 gives minimum equipment required for the respective laboratories.

Table 3-5Laboratory Space

S.No.	Particulars	Area (ft²)	Remarks
1	Aircraft Structure Laboratory	3000	Each labs will include sections necessary. For example, Manufacturing lab will have composite and sheet metal workplace.
2	Aerospace Propulsion Systems Laboratory.	700	
3	Laboratory for Aerospace Manufacturing Techniques.	2600	
4	Aircraft Engine Fault Monitoring and Diagnosis Laboratory.	400	
5	Aircraft Environmental Control Systems Laboratory.	400	
6	Advanced Computational Laboratory	800	
	Sub-Total	**7100**	

The lab equipment given in table 3-6 is basic lab for teaching purpose. In future these laboratories will be developed to research and development (R&D) laboratories. Besides these laboratories has to be easily accessible as some of the equipment of laboratories has specific lab setup requirement.

Table 3-6 Laboratory equipment cost estimation

Laboratory	Basic Infrastructure	Qty.	Estimated Purchase Cost
Aircraft Structures Laboratory	Dissembled Aircraft (excluding the power plant)	1	$30,000 (~NRS 2,886,000/-) for a narrow-body aircraft.
Aerospace Propulsion Systems Laboratory	Gas-Turbine Engine	1	$10,000 (~NRS 962,000/-)
Aircraft Manufacturing Technology Laboratory	Industrial Manufacturing Lab	1	$124,800 (~ NRS 1,20,00,000)
Aircraft Engine Fault Monitoring and Diagnosis	Vibration Testing Equipment	1	$8000 (~NRS 770,000/-)
Environmental Control Systems Laboratory	Pressure Chamber	2	2×$3000 (~NRS 588,000/-)
Yearly CAE Software/Hardware _ Update and Maintenance			8500000/-
Net Factory Cost			$178,800 (~NRS 25706000)
Total Purchase Cost (including 150 % increment from custom tax plus shipping costs)			$447,000 (NRS 6,42,65,000/-)

For example: the Aircraft Structure laboratory will incorporate advanced equipment/tools for fatigue and fracture test equipment. It will also develop as a laboratories where scale and full aircraft models and other different advanced structural designs can be tested. Similarly, the research laboratory for propulsion laboratory will include test bed for measurement techniques in nozzles, cascade and real engines. It will also in-house subsonic and supersonic test bed for turbomachines and advance propulsion system. Also, manufacturing R&D laboratories will include advanced machines such as 3D additive techniques (Layer Deposition, selective Laser sintering – metal and plastics), composite material manufacturing, crystal growth etc. Advanced aircraft fault monitoring and diagnosis for R&D will include non-destructive module and health monitoring equipment of structures. The faculties will be in charge of these advanced R&D laboratories and they will be responsible for setting short and long term plans of these labs.

3.3 Faculties Appointment Plan

For the first four year of the Aerospace program we will require number of Professors, Associate Professors, Assistant Professors, Instructors and Assistant Technician.

Table 3-7 Faculties Hiring plan

Faculties Hiring Schedule			
S.No.	**Faculty Hiring Date**	**No. of Positions for Hiring**	**Remarks**
1	6 months prior to start date of program	Additional 2 Aerospace Faculty	2 Faculty
2	Start of 1st Year	Additional 2 Aero and 4Mechanical Faculty	6 Faculty
3	Start of 2nd Year	Additional 2 Aero and 4 Mechanical Faculty	6 Faculty
4	Start of 3rd Year	Additional 3 Aero and 2 Mechanical Faculty	5 Faculty
5	Start of 4th Year	Additional 1 Aerospace Faculty	1 Faculty
Total Faculties in Aerospace Program [Including 2 previous Aerospace Faculties]			22 Faculties
Note: 22 faculties mentioned above includes Professor, Associate Professors, Assistant Professors, Instructors and Assistant Technicians.			

In order to attract the Aerospace faculties from different part of the country, TU can call for vacancies for permanent positions. This can attract Nepalese academician working abroad and strengthen the program.

4. Budget Estimation

The program cost will include onetime investment cost and operational cost. All the infrastructures such as office buildings, classrooms, space for laboratories, many of laboratories equipment etc. comes under onetime investment/installation cost. While other costs such as faculty/staffs salary, expenses on purchase of office consumable goods and regular maintenance cost comes under operational cost.

4.1 Installation Cost

The major installation costs includes construction space for laboratories, classroom and office rooms. Table below gives the size of the area and cost of the construction of the laboratories for this program. Design of each of these laboratories has to be of specific design criteria. For example, some laboratories requires acoustic proof, while other may need enough air circulation and floor construction to support heavy aircraft structures.

Table 4-1 Laboratory Construction Cost

S.No.	Particulars	Area (ft^2)	Cost (Rs)	Remarks
1	Aircraft Structure Laboratory	3000	90,00,000	
2	Aerospace Propulsion Systems Laboratory.	700	21,00,000	
3	Laboratory for Aerospace Manufacturing Techniques.	2600	78,00,000	
4	Aircraft Engine Fault Monitoring and Diagnosis Laboratory.	400	12,00,000	
5	Aircraft Environmental Control Systems Laboratory.	400	12,00,000	
6	Advanced Computational Laboratory	800	24,00,000	
	Sub-Total	**7900**	**2,37,00,000**	

Besides laboratory construction, the installation cost includes other costs as given in Table 3-4, 3-6, 4-1 and 4-3. The laboratories will be used for research and development in days to come.

4.2 Operational Cost

Operational cost of the program includes salaries of staffs and faculties and other expenses. It also includes the cost of training faculties with advanced tools, purchase of engineering computer software (such as Ansys, Soldiworks, CATIA and hardware required for it). It also includes the purchase of update for the software released yearly. These CAE software will not only help and train the young students but also will help to enhance the research, design and analysis capabilities of the institution. Not only in the Aerospace field, can these software be used by the other departments of IOE, TU for advanced research projects. Many researchers from various departments: Mechanical, Civil, Environment, Physics, Electronics can use these software.

The students of Bachelors of Aerospace Engineering have to undertake internship and project works which accounts for most of their skill development part for future industry. Also, all the final year students of this program will undertake 3 months of intensive internship at airlines.

Table 4-2 Operational cost of the Aerospace Program

S.No.	Faculty/Staffs	No.	Salary (Rs)	Total Salary (Rs)
1	Professor	2	51420	102840
2	Associate Professor	4	40150	160600
3	Assistant Professor	10	34220	342200
4	Instructor	1	30500	30500
5	Assistant Technician	5	23500	117500
6	Administrative Staff	2	23500	47000
7	Store Keeper	1	22170	22170
8	Peon	2	16230	32460
9	Cleaning Staff	1	16230	16230
10	Assistant Accountant	1	22170	22170
			Total (per months)	893670
			Yearly Salary Expenses	11617710
			Yearly Faculty Training, Software Updates and Other Expenses	2500000
			Yearly Internship and Projects	1440000
			Yearly Operation and Maintenance Cost	1500000
			Yearly Sub-Total	17057710
			10% Overhead	1705771
			(Yearly Operational Cost) Total	18763481

Other costs includes cost of computers, printers, pantry equipment. Table 4-3 below gives overview of the total income cost for the office equipment installation costs. For the market uncertainty the 10% overhead is added to the operational cost. Also, the faculties and department will need computer and stationeries for operation. Also, it will include furniture and pantry stuffs.

Table 4-3 Approximate cost for office equipment (initial investment)

S.No.	Particulars	Cost (Rs.)	Remarks
1	Computer, Pantry equipment, printer, office furniture etc.	80,00,000.00	It includes total cost for first four years of office equipment investment.

4.3 Program Sustainability

Students fee increase at the rate of 5% annually in order to address the market inflation. Details of the funding for the initial investment and some running cost have to be secured from government or other possible parties.

4.3.1 Total Cost of Program

The total cost of the program includes onetime installation cost and operational cost. The installation cost are onetime cost which requires regular maintenance. The operational cost includes yearly cost for smooth running of the program. The operational cost includes regular maintenance cost, salaries for faculties and staffs, expenses on daily consumable goods in the office and yearly training/programs fees.

Table 4-4 Total Cost of the Program

S.No.	Particulars	Items	Cost (Rs.)	Remarks
1	Initial Investment Cost	Classroom and Office Buildings	11340000	Table 3-4
		Laboratory Buildings	23700000	Table 4-1
		Laboratory Equipment	64265000	Table 3-6
		Office Equipment	8000000	Table 4-3
		Sub-Total (Initial Investment Cost)	**107305000**	(One time investment)
2	Operational Cost		18763481	(Table: 4-2) Amount per year

S.No.	Initial Onetime Investment (Current Value)	With 12% Interest per annum, 15 year of payback period and using Mortgage formula	Remarks
1	10,73,05,000	19,31,49,000	
Yearly cost because of Onetime initial investment cost			
1	19,31,49,000	1,28,76,600	

The total yearly cost of the program (including operational and one time initial investment cost) is Rs. 3,16,40,081. This amount is used to calculate students' tuition fee in following section.

4.3.2 Revenue from the Program

The students' fee will be major source of the revenue for the Bachelor's Aerospace Program. In order cover the operational cost of the program the fee structure on Table 4-5 is proposed. Regular students means students who receives scholarship and full fee means students who pays full fee as shown in table 4-5 below.

Table 4-5Purposed tuition fee from the students

S.No.	Structure of Classroom	Annual Fee (Rs.)	Remarks
1	48 (12 Regular and 36 Full Fee)	2,19,723	
Note: Above calculated fee is to make the program sustainable for operational cost (i.e. Table: 4-2)			

5. Conclusion and Recommendations

5.1 Conclusions

- Students going abroad for Bachelor of Engineering in Aerospace Engineering pays tuition fee which is very high compared to what is purposed at Institute of Engineering, Pulchowk Campus, Tribhuvan University, Nepal. This program will fulfill the dream of many students who wants to get quality education for minimum cost. Total cost of program for full fee students is 2,19,723 (Two lakhs, nineteen thousand and seven hundred twenty three) per year.
- Aerospace Engineering program can help to boost the development of civil aviation in Nepal. It can also help in the research and development of Unmanned Arial Vehicles (UAVs) for national defense force. The research labs and computational facility at the laboratory will enhance the research skills and capabilities of the institute.
- Graduates of Aerospace Engineering will learn cutting edge technologies, skills, tools and theories. Hence they will be highly competitive to work in many industries and research centers.
- One time investment cost for building infrastructures and laboratory equipment are high. But this will be justifiable with the benefits it will bring to national development.
- Bachelors of Aerospace program is sustainable and feasible to run at Institute of Engineering, Pulchwok Campus, Tribhuvan University, Nepal. It will add research and development in the field of aviation and space engineering in Nepal. The graduates will be consumed in fast growing civil aviation industry of the country.

5.2 Recommendations

- Strong tie-up between civil airlines and Aerospace department/program is necessary to ensure better job opportunities for the graduates of Aerospace Engineers.
- The program should tie-up with national/international research centers and universities for exchange and transfer of technologies and research skills.
- MOU with major airlines of Nepal and international airlines would provide an excellent job opportunity for our fresh graduates.

Syllabus

Year - I, Part - I

Bachelors of **Aerospace Engineering**

Department of Mechanical Engineering

Institute of Engineering

Pulchowk Campus

Tribhuvan University

Date: 31/02/2075

ENGINEERING MATHEMATICS I
SH 401

Lecture: 3 **Year: I**
Tutorial: 2 **Part: I**
Practical : 0

Course Objective:

To provide students a sound knowledge of calculus and analytic geometry to apply them in their relevant fields.

1. Derivatives and their Applications **(14 hours)**

1.1. Introduction
1.2. Higher order derivatives
1.3. Mean value theorem
 1.3.1. Rolle's Theorem
 1.3.2. Lagrange's mean value theorem
 1.3.3. Cauchy's mean value theorem
1.4. Power series of single valued function
 1.4.1. Taylor's series
 1.4.2. Maclaurin's series
1.5. Indeterminate forms; L'Hospital rule
1.6. Asymptotes to Cartesian and polar curves
1.7. Pedal equations to Cartesian and polar curves; curvature and radius of curvature

2. Integration and its Applications **(11 hours)**

2.1. Introduction
2.2. Definite integrals and their properties
2.3. Improper integrals
2.4. Differentiation under integral sign
2.5. Reduction formula; Beta Gama functions
2.6. Application of integrals for finding areas, arc length, surface and solid of revolution in the plane for Cartesian and polar curves

3. Plane Analytic Geometry **(8 hours)**

3.1. Transformation of coordinates: Translation and rotation
3.2. Ellipse and hyperbola; Standard forms, tangent, and normal
3.3. General equation of conics in Cartesian and polar forms

4. Ordinary Differential Equations and their Applications **(12 hours)**

4.1. First order and first degree differential equations
4.2. Homogenous differential equations
4.3. Linear differential equations
4.4. Equations reducible to linear differential equations; Bernoulli's equation
4.5. First order and higher degree differential equation; Clairaut's equation
4.6. Second order and first degree linear differential equations with constant coefficients.
4.7. Second order and first degree linear differential equations with variable coefficients; Cauchy's equations
4.8. Applications in engineering field

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2. Thomas,Finney, "Calculus and Analytical Geometry" Addison- Wesley

3. M. B. Singh, B. C. Bajrachrya, “Differential Calculus”, SukundaPustakBhandar,Nepal
4. M. B. Singh, S. P. Shrestha, “Applied Mathematics”, RTU, Department of Engineering Science and Humanities.
5. G.D. Pant, G. S. Shrestha, “Integral Calculus and Differential Equations”, SunilaPrakashan, Nepal
6. M. R. Joshi, “Analytical Geometry”, SukundaPustakBhandar,Nepal
7. S. P. Shrestha, H. D. Chaudhary, P. R. Pokharel, “A Textbook of Engineering Mathematics - Vol I”, VidyarthiPustakBhandar.
8. Santosh Man Maskey, “Calculus”, RatnaPustakBhandar, Nepal

Evaluation Scheme:
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit Chapter Topics Marks

Unit	**Chapter**	**Topics**	**Marks**
1	1	1.1 to 1.5	16
2	1	1.6 to 1.7	16
	2	2.1 to 2.3	16
3	2	2.4 to 2.6	16
4	3	3.1 to 3.3	16
5	4	4.1 to 4.8	16
Total			80

ENGINEERING DRAWING I
ME 401

Lectures : 1 **Year : I**
Tutorial : 0 **Part : I**
Practical : 3

Course Objective:

To develop basic projection concepts with reference to points, lines, planes and geometrical solids. Also to develop sketching and drafting skills to facilitate communication.

1. Instrumental Drawing, Technical Lettering Practices and Techniques (2 hours)

1.1. Equipment and materials
1.2. Description of drawing instruments, auxiliary equipment and drawing materials
1.3. Techniques of instrumental drawing
1.4. Pencil sharpening, securing paper, proper use of T- squares, triangles, scales dividers, compasses, erasing shields, French curves, inking pens
1.5. Lettering strokes, letter proportions, use of pencils and pens, uniformity and appearance of letters, freehand techniques, inclined and vertical letters and numerals, upper and lower cases, standard English lettering forms

2. Dimensioning (2 hours)

2.1. Fundamentals and techniques
2.2. Size and location dimensioning, SI conversions
2.3. Use of scales, measurement units, reducing and enlarging drawings
2.4. Placement of dimensions: aligned and unidirectional

3. Applied Geometry (6 hours)

3.1. Plane geometrical construction: Proportional division of lines, arc & line tangents
3.2. Methods for drawing standard curves such as ellipses, parabolas, hyperbolas, involutes, spirals, cycloids and helices (cylindrical and conical)
3.3. Techniques to reproduce a given drawing (by construction)

4. Basic Descriptive Geometry (14 hours)

4.1. Introduction to Orthographic projection, Principal Planes, Four Quadrants or Angles
4.2. Projection of points on first, second, third and fourth quadrants
4.3. Projection of Lines: Parallel to one of the principal plane, Inclined to one of the principal plane and parallel to other, Inclined to both principal planes
4.4. Projection Planes: Perpendicular to both principal planes, Parallel to one of the principal planes and Inclined to one of the principal planes, perpendicular to other and Inclined to both principal planes
4.5. True length of lines: horizontal, inclined and oblique lines
4.6. Rules for parallel and perpendicular lines
4.7. Point view or end view of a line
4.8. Shortest distance from a point to a line
4.9. Edge View and True shape of an oblique plane
4.10. Angle between two intersecting lines
4.11. Intersection of a line and a plane
4.12. Angle between a line and a plane
4.13. Dihedral angle between two planes
4.14. Shortest distance between two skew lines
4.15. Angle between two non- intersecting (skew) lines

5. Multi view (orthographic) projections **(18 hours)**

5.1. Orthographic Projections

5.1.1. First and third angle projection

5.1.2. Principal views: methods for obtaining orthographic views, projection of lines, angles and plane surfaces, analysis in three views, projection of curved lines and surfaces, object orientation and selection of views for best representation, full and hidden lines

5.1.3. Orthographic drawings: making an orthographic drawing, visualizing objects (pictorial view) from the given views

5.1.4. Interpretation of adjacent areas, true-length lines, representation of holes, conventional practices

5.2. Sectional Views: Full, half, broken revolved, removed (detail) sections, phantom of hidden section, Auxiliary sectional views, specifying cutting planes for sections, conventions for hidden lines, holes, ribs, spokes

5.3. Auxiliary views: Basic concept and use, drawing methods and types, symmetrical and unilateral auxiliary views. projection of curved lines and boundaries, line of intersection between two planes, true size of dihedral angles, true size and shape of plane surfaces

6. Developments and Intersections **(18 hours)**

6.1. Introduction and Projection of Solids

6.2. Developments: general concepts and practical considerations, development of a right or oblique prism, cylinder, pyramid, and cone, development of truncated pyramid and cone, Triangulation method for approximately developed surfaces, transition pieces for connecting different shapes, development of a sphere

6.3. Intersections: lines of intersection of geometric surfaces, piercing point of a line and a geometric solid, intersection lines of two planes, intersections of -prisms and pyramids, cylinder and an oblique plane. Constructing a development using auxiliary views, intersection of – two cylinders, a cylinder & a cone

Practical:

1. Drawing Sheet Layout, Freehand Lettering, Sketching of parallel lines, circles, Dimensioning
2. Applied Geometry (Sketch and Instrumental Drawing)
3. Descriptive Geometry I: Projection of Point and Lines (4.1 to 4.3)(Sketch and Instrumental Drawing)
4. Descriptive Geometry II: Projection of Planes (4.4) (Sketch and Instrumental Drawing)
5. Descriptive Geometry III: Applications in Three dimensional Space (4.5 to4.15) (Sketch and Instrumental Drawing)
6. Multiview Drawings (5.1) (Sketch and Instrumental Drawing)
7. Multiview, Sectional Drawings and Dimensioning I (5.2) (Sketch and Instrumental Drawing)
8. Multiview, Sectional Drawings and Dimensioning II (5.2) (Sketch and Instrumental Drawing)
9. Auxiliary View, Sectional Drawings and Dimensioning (5.3) (Sketch and Instrumental Drawing)
10. Projection of Regular Geometrical Solids (Sketch and Instrumental Drawing)
11. Development and Intersection I (6.1) (Sketch and Instrumental Drawing)
12. Development and Intersection II (6.2) (Sketch and Instrumental Drawing)

13. Development and Intersection III (6.3) (Sketch and Instrumental Drawing)

References:

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2. T. E. French, C. J. Vierck, and R. J. Foster, “Engineering Drawing and Graphic Technology”, McGraw Hill Publshing Co.
3. A . Mitchell, H. C. Spencer and J. T. Dygdone, “Technical Drawing”, F. E. Giescke, Macmillan Publshing Co.
4. N. D. Bhatt, “Elementary Engineering Drawing”, CharotarPublshing House, India.
5. P. S. Gill, “A Text Book of Engineering Drawing”, S. K. Kataria and Sons, India
6. R. K. Dhawan, “A Text Book of Engineering Drawing”, S. Chand and Company Limited, India

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	3	All	4
2	4	All	8
3	1, 2 and 5	All	14
4	6	All	14
Total			40

WORKSHOP TECHNOLOGY
ME 403

Lecture : 1 **Year : I**
Tutorial : 0 **Part : I**
Practical : 3

Course Objective:

To impart knowledge and skill components in the field of basic workshop technology. To be familiar with different hand and machine tools required for manufacturing simple metal components and articles.

1. General Safety Considerations **(2 hours)**

1.1. Bench Tools
1.2. Machinist's Hammers
1.3. Screw Drivers
1.4. Punches
1.5. Chisels
1.6. Scrapers
1.7. Scribers
1.8. Files
1.9. Pliers and Cutters
1.10. Wrenches
1.11. Hacksaw
1.12. Bench Vise
1.13. Hand drill
1.14. Taps and Dies
1.15. Hand Shears
1.16. Rules, Tapes and Squares
1.17. Soldering Iron
1.18. Rivets

2. Hand Working Operations **(1 hours)**

2.1. Sawing
2.2. Filing
2.3. Threading
2.4. Scribing
2.5. Shearing
2.6. Soldering
2.7. Riveting

3. Measuring and Gauging **(1hours)**

3.1. Introduction
3.2 Semi – Precision Tools – Calipers, depth Gauge, Feeler Gauge
3.3 Precision Tools – Micrometers, Vernier Calipers, Vernier Height Gauge, Telescopic Gauge, Hole Gauge, Bevel Protractor, Dial Indicator, Gauge Blocks and Surface Plate

4. Drills and Drilling Processes **(1 hours)**

4.1 Introduction
4.2 Types of Drill Presses
4.3 Work Holding Devices and Accessories
4.4 Cutting Tools

4.5 Geometry of Drill Bits
4.6 Grinding of Drill Bits
4.7 Operations – Drilling, Counter - boring, Counter - sinking, Reaming, Honning, Lapping
4.8 Cutting Speeds
4.9 Drilling Safety

5. Machine Tools **(4 hours)**

5.1. General Safety Considerations
5.2 Engine Lathes
- 5.2.1 Introduction
- 5.2.2 Physical Construction
- 5.2.3 Types of Lathe
- 5.2.4 Lathe Operations – Facing, Turning, Threading

5.3 Shapers
- 5.3.1 Introduction
- 5.3.2 Types of Shapers
- 5.3.3 Physical Construction
- 5.3.4 General Applications

5.4 Milling Machines
- 5.4.1 Introduction
- 5.4.2 Types of Milling Machines
- 5.4.3 Physical Construction
- 5.4.4 Milling Cutters – Plain, Side, Angle, End, Form
- 5.4.5 Milling Operations – Plain, Side, Angular, Gang, End, Form, Keyway
- 5.4.6 Work Holding Devices
- 5.4.7 Cutter Holding Devices

5.5 Grinding Machines
- 5.5.1 Abrasives, Bonds, Grinding Wheels
- 5.5.2 Rough Grinders – Portable Grinders, Bench Grinders, Swing Frame Grinders, Abrasive Belt Grinders
- 5.5.3 Precision Grinders – Cylindrical Grinders, Surface Grinders

6. Material Properties **(1 hours)**

6.1. Tool materials – Low, medium and high carbon steels; Hot and cold rolled steels; Alloy steels; Carbide and Ceramic materials
6.2. Heat treating methods for steels – Annealing, Tempering, Normalizing, Hardening and Quenching
6.3. Non – ferrous metals – Brass, Bronze, Aluminum – Comparative Properties

7. Sheet Metal Works **(1 hours)**

7.1. Introduction
7.2. Sheet Metal Tools
7.3. Marking and Layout
7.4. Operations – Bending, Cutting, Rolling

8. Foundry Practice **(1 hours)**

8.1. Introduction
8.2. Pattern Making
8.3. Foundry Tools

8.4. Core Making
8.5. Melting Furnace – Cupola
8.6. Sand Casting Process

9. Forging Practice (1 hours)

9.1. Introduction
9.2. Forging Tools
9.3. Operations – Upsetting, Drawing, Cutting, Bending, Punching
9.4. Forging Presses and Hammers
9.5. Advantages and Limitations

10. Metal Joining (2 hours)

10.1 Safety Considerations
10.2 Introduction
10.3 Soldering
10.4 Brazing
10.5 Welding – Gas Welding, Arc Welding, Resistance Welding, Tungsten Inert Gas Welding (TIG), Metal Inert Gas Welding (MIG)

Practical:

1. Bench Tools and hand operations: Measuring, Marking, Layout, Cutting, Filling, Drilling, Tapping, Assembly
2. Bench Tools and hand operations: (Contd.)
3. Drilling machines
4. Measuring and Gauging Instruments
5. Engine lathe: Basic operations such as Plain turning, facing, cutting off, knurling.
6. Engine lathe: Taper turning, drilling and boring
7. Basic Shaper Operations
8. Milling Machines
9. Grinding Machines
10. Sheet Metal works
11. Foundry Practice
12. Forging Practice
13. Electric Arc Welding
14. Gas Welding

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2. O. D. Lascoe, C. A. Nelson and H. W. Porter, "Machine shop operations and setups", American Technical society.
3. "Machine shop Practice – Vol. I" , Industrial Press, New York.
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6. Oberg, Jones and Horton, "Machinery's Handbook", Industrial Press, New York.
7. S. K. Hajra Choudhury and A. K. Hajra Choudhury, "Elements of Workshop Technology - Vol. I (Manufacturing Processes)", Media Promoters and Publishers Pvt. Ltd. , Bombay, INDIA.

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12. H. S. Bawa, “Workshop Technology - Vol. II” , Tata Mc – Graw Hill publishing company Limited, New Delhi, INDIA,
13. R. S. Khurmi and J. K. Gupta, “A text book of Workshop Technology”, S. Chand and Company Ltd, New Delhi. INDIA

ENGINEERING PHYSICS
SH 452

Lecture : 4 **Year : I**
Tutorial : 1 **Part : I**
Practical : 2

Course objectives:

To provide the concept and knowledge of physics with the emphasis of present day application.

1. Oscillation: **(7 hours)**
- 1.1. Mechanical Oscillation: Introduction
- 1.2. Free oscillation
- 1.3. Damped oscillation
- 1.4. forced mechanical oscillation
- 1.5. EM Oscillation: Free, damped and Forced electromagnetic oscillation

2. Wave motion **(2 hours)**
- 2.1. Waves and particles,
- 2.2. Progressive wave,
- 2.3. Energy, power and intensity of progressive wave

3. Acoustics **(3 hours)**
- 3.1. Reverberation,
- 3.2. Sabine' Law
- 3.3. Ultrasound and its applications

4. Physical Optics **(12 hours)**
- **4.1. Interference,**
  - 4.1.1. Intensity in double slit interference,
  - 4.1.2. Interference in thin films,
  - 4.1.3. Newton's rings,
  - 4.1.4. Hadinger fringes
- **4.2. Diffraction,**
  - 4.2.1. Fresnel and Fraunhoffer’s diffraction,
  - 4.2.2. Intensity due to a single slit;
  - 4.2.3. Diffraction grating,
  - 4.2.4. X-ray diffraction, x-ray for material test
- **4.3. Polarization,**
  - 4.3.1. Double refraction,
  - 4.3.2. Nichol prism, wave plates,
  - 4.3.3. Optical activity, specific rotation

5. Geometrical Optics **(3 hours)**
- 5.1. Lenses, combination of lenses,
- 5.2. Cardinal points,
- 5.3. Chromatic aberration

6. Laser and Fiber Optics **(4 hours)**
- **6.1. Laser production,**
  - 6.1.1. He-Ne laser,
  - 6.1.2. Uses of laser
- **6.2. Fiber Optics,**
  - 6.2.1. Self-focusing,

6.2.2. Applications of optical fiber

7. Electrostatics **(8 hours)**

7.1. Electric charge and force,
7.2. Electric field and potential,
7.3. Electrostatic potential energy,
7.4. Capacitors, capacitor with dielectric,
7.5. Charging and discharging of a capacitor

8. Electromagnetism **(11 hours)**

8.1. **Direct current:** Electric current,
8.1.1. Ohm's law, resistance and resistivity,
8.1.2. Semiconductor and superconductor

8.2. Magnetic fields:
8.2.1. Magnetic force and Torque,
8.2.2. Hall effect,
8.2.3. Cyclotron, synchrotron,
8.2.4. Biot-Savart law,
8.2.5. Ampere’s circuit law; magnetic fields straight conductors,
8.2.6. Faraday’s laws, Induction and energy transformation, induced field,
8.2.7. LR circuit, induced magnetic field,
8.2.8. Displacement current

9. Electromagnetic waves **(5 hours)**

9.1. Maxwell’s equations,
9.2. Wave equations, speed,
9.3. E and B fields,
9.4. Continuity equation,
9.5. Energy transfer

10. Photon and matter waves **(5 hours)**

10.1. Quantization of energy;
10.2. Electrons and matter waves;
10.3. Schrodinger wave equation;
10.4. Probability distribution;
10.5. One dimensional potential well;
10.6. Uncertainty principle;
10.7. Barrier tunneling

Practical:

1. To determine the acceleration due to gravity and radius of gyration of the bar about an axis passing through its center of gravity.
2. To determine the value of modulus of elasticity of the materials given and moment of inertia of a circular disc using torsion pendulum.
3. To determine the angle of prism and dispersive power of materials of the prism using spectrometer.
4. To determine the wavelength of sodium light by Newton's rings.
5. To determine the wavelength of He-Ne laser light and use it to measure the thickness of a thin wire by diffraction of light.

6. To study the variation of angle of rotation of plane of polarization using concentration of the cane sugar solution
7. To determine the specific rotation of the cane sugar solution using polarimeter.
8. To determine the low resistance of a given wire by Carey Foster bridge and to determine the resistance per unit length of the wire of the bridge.
9. To determine the capacitance of a given capacitor by charging and discharging through resistor.
10. To plot a graph between current and frequency in an LRC series circuit and find the resonant frequency and quality factor.
11. To determine dielectric constant of a given substance and study its variation with frequency by resonance method.
12. To determine the susceptibility of a solution of given materials by Quinkes method.
13. To study the electric field mapping.

References:

1. Halliday, Resnick, Walker, “Fundamentals of Physics”, John Wiley & Sons. Inc.
2. Sapkota, Pokharel, Bhattarai, "Fundamentals of Engineering Physics", Benchmark Publication.
3. BrijLal and Subrahmanyam, “A text book of Optics”, S. Chand Publisher.
4. A. S. Basudeva, “Modern Engineering Physics”, S. Chand Publisher.
5. R. K. Gaur and S. L. Gupta, “Engineering Physics”, Dhanpat Publisher.
6. BrijLal and Subrahmanyam, “Waves and Oscillation”, S. Chand Publisher.

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 3	All	16
2	4	All	16
3	5, 6 & 10	All	16
4	7 & 8.1	All	16
5	8.2 & 9	All	16
Total			80

APPLIED MECHANICS
CE 451

Lecture : 3 **Year : I**
Tutorial : 2 **Part : I**
Practical : 0

Course Objective:
To provide concept and knowledge of engineering mechanics and help understand structural engineering stress analysis principles in later courses or to use basics of mechanics in their branch of engineering. Emphasis has been given to Statics.

1. Introduction **(2 hours)**

1.1 Definitions and scope of Applied Mechanics
1.2 Concept of Rigid and Deformed Bodies
1.3 Fundamental concepts and principles of mechanics: Newtonian Mechanics

2. Basic Concept in Statics and Static Equilibrium **(4 hours)**

2.1 Concept of Particles and Free Body Diagram
2.2 Physical meaning of Equilibrium and its essence in structural application
2.3 Equation of Equilibrium in Two Dimension

3. Forces Acting on Particle and Rigid Body **(6 hours)**

3.1 Different types of Forces: Point, Surface Traction and Body Forces - Translational Force and Rotational Force: Relevant Examples
3.2 Resolution and Composition of Forces: Relevant Examples
3.3 Principle of Transmissibility and Equivalent Forces: Relevant Examples
3.4 Moments and couples: Relevant Examples
3.5 Resolution of a Force into Forces and a Couple: Relevant Examples
3.6 Resultant of Force and Moment for a System of Force: Examples

4. Center of Gravity, Centroid and Moment of Inertia **(6 hours)**

4.1 Concepts and Calculation of Centre of Gravity and Centroid: Examples
4.2 Calculation of Second Moment of Area / Moment of Inertia and Radius of Gyration: And Relevant usages
4.3 Use of Parallel axis Theorem: Relevant Examples

5. Friction **(2 hours)**

5.1 Laws of Friction, Static and Dynamic Coefficient of Friction, Angle of Friction: Engineering Examples of usage of friction
5.2 Calculations involving friction in structures: Example as High Tension Friction Grip bolts and its free body diagram

6. Analysis of Beams and Frames **(9 hours)**

6.1 Introduction to Structures: Discrete and Continuum
6.2 Concept of Load Estimating and Support Idealizations: Examples and Standard symbols
6.3 Use of beams/frames in engineering: Concept of rigid joints/distribute loads in beams/frames.
6.4 Concept of Statically/Kinematically Determinate and Indeterminate Beams and Frames: Relevant Examples
6.5 Calculation of Axial Force, Shear Force and Bending Moment for Determinate Beams and Frames

6.6 Axial Force, Shear Force and Bending Moment Diagrams and Examples for drawing it.

7. Analysis of Plane Trusses (4 hours)

7.1 Use of trusses in engineering: Concept of pin joints/joint loads in trusses.
7.2 Calculation of Member Forces of Truss by method of joints: Simple Examples
7.3 Calculation of Member Forces of Truss by method of sections: Simple Examples

8. Kinematics of Particles and Rigid Body (7 hours)

8.1 Rectilinear Kinematics: Continuous Motion
8.2 Position, Velocity and Acceleration of a Particle and Rigid Body
8.3 Determination of Motion of Particle and Rigid Body
8.4 Uniform Rectilinear Motion of Particles
8.5 Uniformly Accelerated Rectilinear Motion of Particles
8.6 Curvilinear Motion: Rectangular Components with Examples of Particles

9. Kinetics of Particles and Rigid Body: Force and Acceleration (5 hours)

9.1 Newton's Second Law of Motion and momentum
9.2 Equation of Motion and Dynamic Equilibrium: Relevant Examples
9.3 Angular Momentum and Rate of Change
9.4 Equation of Motion-Rectilinear and Curvilinear
9.5 Rectangular: Tangential and Normal Components and Polar Coordinates: Radialand Transverse Components

Tutorial:

There shall be related tutorials exercised in class and given as regular homeworkexercises. Tutorials can be as following for each specified chapters.

1. Introduction (1 hour)

A. Theory; definition and concept type questions.

2. Basic Concept in Statics and Static Equilibrium (2 hours)

A. Theory; definition and concept type questions.

3. Concept of Force acting on structures (3 hours)

A. Practical examples; numerical examples and derivation types of questions.
B. There can be tutorials for each sub-section.

4. Center of Gravity, Centroid and Moment of Inertia (4 hours)

A. Concept type; numerical examples and practical examples type questions.

5. Friction (2 hours)

A. Definition type; Practical example type and numerical type questions.

6. Analysis of Beam and Frame (5 hours)

A. Concept type; definition type; numerical examples type with diagrams questions.
B. There can be tutorials for each sub-section.

7. Analysis of Plane Trusses (5 hours)

A. Concept type; definition type; numerical examples type questions.
B. There can be tutorials for each sub-section.

8. Kinematics of Particles and Rigid Body (4 hours)

A. Definition type; numerical examples type questions.
B. There can be tutorials for each sub-section.

9. Kinetics of Particles and Rigid Body: Force and Acceleration (4 hours)

A. Concept type; definition type; numerical examples type questions.
B. There can be tutorials for each sub-section.

References:

1. F.P. Beer and E.R. Johnston, Jr.,“Mechanics of Engineers- Statics and Dynamics”, McGraw-Hill.
2. R.C. Hibbeler, Ashok Gupta, “Engineering Mechanics-Statics and Dynamics”, NewDelhi, Pearson.
3. I.C. Jong and B.G. Rogers, “Engineering Mechanics- Statics and Dynamics”,
4. D.K. Anand and P.F. Cunnif, “Engineering Mechanics- Statics and Dynamics”,
5. R.S. Khurmi, “A Text Book of Engineering Mechanics”,
6. R.S.Khurmi, “Applied Mechanics and Strength of Materials”,
7. I.B.Prasad, “A Text Book of Applied Mechanics”,
8. Shame, I.H., “Engineering Mechanics-Statics and Dynamics”, Prentice Hall of India, New Delhi.

Evaluation Scheme

The questions will cover all the chapters of the syllabus. The evaluation schemewill be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1 & 2	All	16
	3	3.1 to 3.3	
2	4 & 5	All	16
3	6	All	16
4	7 & 8	All	16
5	3	3.4 to 3.6	16
	9	All	
Total			80

BASIC ELECTRICAL ENGINEERING
EE 451

Lecture : 3 **Year : I**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives:
To provide the fundamental concept of DC, AC & 3-phase electrical circuits

1. General Electric System **(6 hours)**
1.1. Constituent parts of an electrical system (source, load, communication & control)
1.2. Current flow in a circuit
1.3. Electromotive force and potential difference
1.4. Electrical units
1.5. Ohm's law
1.6. Resistors, resistivity
1.7. Temperature rise & temperature coefficient of resistance
1.8. Voltage & current sources

2. DC circuits **(4 hours)**
2.1. Series circuits
2.2. Parallel networks
2.3. Krichhhof's laws
2.4. Power and energy

3. Network Theorems **(12 hours)**
3.1. Application of Krichhof's laws in network solution
3.1.1. Nodal Analysis
3.1.2. Mesh analysis
3.2. Star-delta & delta-star transformation
3.3. Superposition theorem
3.4. Thevninn's theorem
3.5. Nortan's theorem
3.6. Maximum power transfer theorem
3.7. Reciprocity theorem

4. Inductance & Capacitance in electric circuits **(4 hours)**
4.1. General concept of capacitance
4.1.1. Charge & voltage
4.1.2. Capacitors in series and parallel
4.2. General concept of inductance
4.2.1. Inductive & non-inductive circuits
4.2.2. Inductance in series & parallel

5. Alternating Quantities **(3 hours)**
5.1. AC systems
5.2. Wave form, terms & definitions
5.3. Average and rms values of current & voltage
5.4. Phasor representation

6. Single-phase AC Circuits **(6 hours)**
6.1. AC in resistive circuits
6.2. Current & voltage in an inductive circuits

6.3. Current and voltage in an capacitive circuits
6.4. Concept of complex impedance and admittance
6.5. AC series and parallel circuit
6.6. RL, RC and RLC circuit analysis &phasor representation

7. Power in AC Circuits **(4 hours)**

7.1. Power in resistive circuits
7.2. Power in inductive and capacitive circuits
7.3. Power in circuit with resistance and reactance
7.4. Active and reactive power
7.5. Power factor, its practical importance
7.6. Improvement of power factor
7.7. Measurement of power in a single-phase AC circuits

8. Three-Phase Circuit Analysis **(6 hours)**

8.1. Basic concept & advantage of Three-phase circuit
8.2. Phasor representation of star & delta connection
8.3. Phase and line quantities
8.4. Voltage & current computation in 3-phase **balance & unbalance** circuits
8.5. Real and reactive power computation
8.6. Measurements of power & power factor in 3-phase system

Practical:

1. Measurement of Voltage, current& power in DC circuit Verification of Ohm’s Law Temperature effects in Resistance
2. Krichoff’s Voltage & current Law Evaluate power from V & I Note loading effects of meter
3. Measurement amplitude, frequency and time with oscilloscope Calculate & verify average and rms value Examine phase relation in RL & RC circuit
4. Measurements of alternating quantities R, RL,RC circuits with AC excitation AC power, power factor, VARs, phasor diagrams
5. Three-phase AC circuits Measure currents and voltages in three-phase balanced AC circuits Prove Y-Δ transformation Exercise on phasor diagrams for three-phase circuits
6. Measurement of Voltage, current & power in a three-phase circuit Two-wattmeter method of power measurement in R, RL and RC three phase circuits Watts ratio curve

References:

1. J. R. Cogdell, “Foundations of Electrical Engineering”, Prentice Hall, Englewood Chiffs, New Jersy, 1990.
2. I. M. Smith,” Haughes Electrical Technology”, Addison-Wesley, ISR Reprint,2000

Evaluation Scheme

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	All	16
2	3	All	16
3	4, 5 & 7	All	16
4	6	All	16
5	8	All	16
Total			80

Syllabus

Year - I, Part - II

Bachelors of **Aerospace Engineering**

Department of Mechanical Engineering

Institute of Engineering

Pulchowk Campus

Tribhuvan University

Date: 31/02/2075

ENGINEERING MATHEMATICS II
SH 451

Lecture: 3 **Year: I**
Tutorial: 2 **Part: II**
Practical: 0

Course Objective:

To develop the skill of solving differential equations and to provide knowledge of vector algebra and calculus. To make students familiar with calculus of several variables and infinite series.

1. Calculus of Two or More Variables **(6 hours)**

- 1.1. Introduction: limit and continuity
- 1.2. Partial derivatives
  - 1.2.1. Homogeneous function, Euler's theorem for the function of two and three variables
  - 1.2.2. Total derivatives
- 1.3. Extrema of functions of two and three variables; Lagrange's Multiplier

2. Multiple Integrals **(6 hours)**

- 2.1. Introduction
- 2.2. Double integrals in Cartesian and polar form; change of order of integration
- 2.3. Triple integrals in Cartesian, cylindrical and spherical coordinates;
- 2.4. Area and volume by double and triple integrals

3. Three Dimensional Solid Geometry **(11 hours)**

- 3.1. The straight line; Symmetric and general form
- 3.2. Coplanar lines
- 3.3. Shortest distance
- 3.4. Sphere
- 3.5. Plane Section of a sphere by planes
- 3.6. Tangent Planes and lines to the spheres
- 3.7. Right circular cone
- 3.8. Right circular cylinder

4. Solution of Differential Equations in Series and Special Functions **(9 hours)**

- 4.1. Solution of differential equation by power series method
- 4.2. Legendre's equation
- 4.3. Legendre polynomial function; Properties and applications.
- 4.4. Bessel's equation
- 4.5. Bessel's function of first and second kind. Properties and applications

5. Vector Algebra and Calculus **(8 hours)**

- 5.1. Introduction
- 5.2. Two and three dimensional vectors
- 5.3. Scalar products and vector products
- 5.4. Reciprocal System of vectors
- 5.5. Application of vectors: Lines and planes
- 5.6. Scalar and vector fields
- 5.7. Derivatives – Velocity and acceleration
- 5.8. Directional derivatives

6. Infinite Series **(5 hours)**

- 6.1. Introduction

6.2. Series with positives terms
6.3. Convergence and divergence
6.4. Alternating series. Absolute convergence
6.5. Radius and interval of convergence

References:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons Inc.
2. Thomas, Finney, "Calculus and Analytical Geometry", Addison- Wesley
3. M. B. Singh, B. C. Bajrachrya, "Differential Calculus", SukundaPustakBhandar,Nepal
4. M. B. Singh, B. C. Bajrachrya, "A Text Book of Vectors", SukundaPustakBhandar,Nepal
5. M. B. Singh, S. P. Shrestha, "Applied Engineering Mathematics", RTU, Department of Engineering Science and Humanities.
6. G.D. Pant, G. S. Shrestha, "Integral Calculus and Differential Equations", SunilaPrakashan,Nepal
7. Y. R. Sthapit, B. C. Bajrachrya, "A Text Book of Three Dimensional Geometry", SukundaPustakBhandar,Nepal
8. Santosh Man Maskey, "Calculus", RatnaPustakBhandar, Nepal

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	All	16
	2	2.1 to 2.2	
2	2	2.3 to 2.4	16
	3	3.1 to 3.3	
3	3	3.4 to 3.8	16
	4	4.1	
4	4	4.2 to 4.5	16
	5	5.1 to 5.5	
5	5	5.6 to 5.8	16
	6	All	
Total			80

ENGINEERING DRAWING II
ME 451

Lecture: 1 **Year: I**
Tutorial: 0 **Part: II**
Practical: 3

Course Objective:

To make familiar with the conventional practices of sectional views. To develop basic concept and skill of pictorial drawing and working drawings. Also to make familiar with standard symbols of different engineering fields.

1. Conventional Practices for Orthographic and Sectional Views (12 hours)

1.1 Conventional Practices in Orthographic views: Half Views and Partial Views, Treatment of Unimportant Intersections, Aligned Views, Treatment for Radially Arranged Features, Representation of Fillets and Rounds

1.2 Conventional Practices in Sectional views: Conventions for Ribs, Webs and Spokes in Sectional View, Broken Section, Removed Section, Revolved Section, Offset Section, Phantom Section and Auxiliary Sectional Views

1.3 Simplified Representations of Standard Machine Elements

2. Pictorial Drawings (20 hours)

2.1 Classifications: Advantages and Disadvantages

2.2 Axonometric Projection: Isometric Projection and Isometric Drawing

- 2.2.1 Procedure for making an isometric drawing
- 2.2.2 Isometric and Non-isometric Lines; Isometric and Non-isometric Surfaces
- 2.2.3 Angles in Isometric Drawing
- 2.2.4 Circles and Circular Arcs in Isometric Drawing
- 2.2.5 Irregular Curves in Isometric Drawing
- 2.2.6 Isometric sectional Views

2.3 Oblique Projection and Oblique Drawing

- 2.3.1 Procedure for making an Oblique drawing
- 2.3.2 Rules for Placing Objects in Oblique drawing
- 2.3.3 Angles, Circles and Circular Arcs in Oblique drawing

2.4 Perspective Projection

- 2.4.1 Terms used in Perspective Projection
- 2.4.2 Parallel and Angular Perspective
- 2.4.3 Selection of Station Point

3. Familiarization with Different Components and Conventions (8 hours)

3.1 Limit Dimensioning and Machining Symbols

- 3.1.1 Limit, Fit and Tolerances
- 3.1.2 Machining Symbols and Surface Finish

3.2 Threads, Bolts and Nuts

- 3.2.1 Thread Terms and Nomenclature, Forms of Screw Threads
- 3.2.2 Detailed and Simplified Representation of Internal and External Threads
- 3.2.3 Thread Dimensioning
- 3.2.4 Standard Bolts and Nuts: Hexagonal Head and Square Head
- 3.2.5 Conventional Symbols for Bolts and Nuts

3.3 Welding and Riveting

- 3.3.1 Types of Welded Joints and Types of Welds, Welding Symbols

3.3.2 Forms and Proportions for Rivet Heads, Rivet Symbols, Types of Riveted Joints: Lap Joint, Butt Joint

3.4 Familiarization with Graphical Symbols and Conventions in Different Engineering Fields

3.4.1 Standard Symbols for Civil, Structural and Agricultural Components

3.4.2 Standard Symbols for Electrical, Mechanical and Industrial Components

3.4.3 Standard Symbols for Electronics, Communication and Computer Components

3.4.4 Topographical Symbols

3.5 Standard Piping Symbols and Piping Drawing

4. Detail and Assembly Drawings (20 hours)

4.1 Introduction to Working Drawing

4.2 Components of Working Drawing: Drawing Layout, Bill of Materials, Drawing Numbers

4.3 Detail Drawing

4.4 Assembly Drawing

4.5 Practices of Detail and Assembly Drawing: V-block Clamp, Centering Cone, Couplings, Bearings, Anti-vibration Mounts, Stuffing Boxes, Screw Jacks, etc.

Practical:

1. Conventional Practices for Orthographic and Sectional Views (Full and Half Section)
2. Conventional Practices for Orthographic and Sectional Views (Other Type Sections)
3. Isometric Drawing
4. Isometric Drawing (Consisting of Curved Surfaces and Sections)
5. Oblique Drawing
6. Perspective Projection
7. Familiarization with Graphical Symbols (Limit, Fit, Tolerances and Surface Roughness Symbols)
8. Familiarization with Graphical Symbols (Symbols for Different Engineering Fields)
9. Detail Drawing
10. Assembly Drawing I
11. Assembly Drawing II
12. Building Drawing

References:

1. W. J. Luzadder, “Fundamentals of Engineering Drawing”, Prentice Hall.
2. T. E. French, C. J. Vierck, and R. J. Foster, “Engineering Drawing and Graphic Technology”, McGraw Hill Publshing Co.
3. F. E. Giescke, A . Mitchell, H. C. Spencer and J. T. Dygdone, “Technical Drawing”, Macmillan Publshing Co.
4. N. D. Bhatt, “Machine Drawing”, CharotarPublishing House, India.
5. P. S. Gill, “Machine Drawing”, S. K. Kataria and Sons, India.
6. R. K. Dhawan “Machine Drawing”, S. Chand and Company Limited, India.

Evaluation Scheme:
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	All	5
2	2	All	15
3	3	All	5
4	4	All	15
Total			40

BASIC ELECTRONICS ENGINEERING
EX 451

Lecture : 3 **Year : I**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:

To understand the electronics elements and their functionality, basic understanding of analog and digital systems and their applications

1. Basic Circuits Concepts **(4 hours)**

1.1 Passive components: Resistance, Inductance, Capacitance; series, parallel combinations; Kirchhoff's law: voltage, current; linearity

1.2 Signal sources: voltage and current sources; nonideal sources; representation under assumption of linearity; controlled sources: VCVS, CCVS, VCCS, CCCS; concept of gain, transconductance, transimpedance.

1.3 Superposition theorem; Thevenin's theorem; Norton's theorem

1.4 Introduction to filter

2. Diodes **(6 hours)**

2.1 Semiconductor diode characteristics

2.2 Modeling the semiconductor diode

2.3 Diode circuits: clipper; clamper circuits

2.4 Zener diode, LED, Photodiode, varacters diode, Tunnel diodes

2.5 DC power supply: rectifier-half wave, full wave (center tapped, bridge), Zener regulated power supply

3. Transistor **(8 hours)**

3.1 BJT configuration and biasing, small and large signal model

3.2 T and μ model

3.3 Concept of differential amplifier using BJT

3.4 BJT switch and logic circuits

3.5 Construction and working principle of MOSFET and CMOS

3.6 MOSFET as logic circuits

4. The Operational Amplifier and Oscillator **(7 hours)**

4.1 Basic model; virtual ground concept; inverting amplifier; non-inverting amplifier; integrator; differentiator, summing amplifier and their applications

4.2 Basic feedback theory; positive and negative feedback; concept of stability; oscillator

4.3 Waveform generator using op-amp for Square wave, Triangular wave Wien bridge oscillator for sinusoidal waveform

5. Communication System **(4 hours)**

5.1 Introduction

5.2 Wired and wireless communication system

5.3 EMW and propagation, antenna, broadcasting and communication

5.4 Internet / intranet

5.5 Optical fiber

6. Digital Electronics **(11 hours)**

6.1 Number systems, Binary arithmetic

6.2 Logic gates: OR, NOT, AND NOR, NAND, XOR, XNOR gate; Truth tables

6.3 Multiplexers; Demux, Encoder, Decoder

6.4 Logic function representation
6.5 Combinational circuits: SOP, POS form; K-map;
6.6 Latch, flip-flop: S-R flip-flop; JK master slave flip-flop; D-flip flop
6.7 Sequential circuits: Generic block diagram; sift registers; counters

7. Application of Electronic System **(5 hours)**

7.1 Instrumentation system: Transducer, strain gauge, DMM, Oscilloscope
7.2 Regulated power supply
7.3 Remote control, character display, clock, counter, measurements, date logging, audio video system

Practical:

1. Familiarization with passive components, function generator and oscilloscope
2. Diode characteristics, rectifiers, Zener diodes
3. Bipolar junction transistor characteristics and single stage amplifier
4. Voltage amplifiers using op-amp, Comparators, Schmitt
5. Wave generators using op-amp
6. Combinational and sequential circuits

References

1. Robert Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory" PHI
2. Thomas L. Floyd, "Electronic Devices" Pearson Education, Inc., 2007
3. A.S. Sedra and K.C. Smith, "Microelectronic Circuits", Oxford University Press, 2006

Evaluation Scheme

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1 & 2	All	16
2	3	All	16
3	4	All	16
4	5 & 7	All	16
5	6	All	16
Total			80

COMPUTER PROGRAMMING
CT 401

Lecture : 3 **Year : I**
Tutorial : 0 **Part : II**
Practical : 3

Course Objective:

To familiarize the student with computer software and high level programming languages and to develop the programming skill using C language

1. Overview of computer software & programming languages **(3 hours)**
- 1.1. System software
- 1.2. Application software
- 1.3. General software features and recent trends
- 1.4. Generation of programming languages
- 1.5. Categorization of high level languages

2. Problem solving using Computer **(3 hours)**
- 2.1. Problem analysis
- 2.2. Algorithm development and Flowchart
- 2.3. Compilation and Execution
- 2.4. Debugging and Testing
- 2.5. Programming Documentation

3. Introduction to 'C' programming **(4 hours)**
- 3.1. Character set, Keywords, and Data types
- 3.2. Preprocessor Directives
- 3.3. Constants and Variables
- 3.4. Operators and statements

4. Input and Output **(3 hours)**
- 4.1. Formatted input/output
- 4.2. Character input/output
- 4.3. Programs using input/output statements

5. Control statements **(6 hours)**
- 5.1. Introduction
- 5.2. The goto, if, if … … else, switch statements
- 5.3. The while, do … while, for statements

6. User-Defined Functions **(4 hours)**
- 6.1. Introduction
- 6.2. Function definition and return statement
- 6.3. Function Prototypes
- 6.4. Function invocation, call by value and call by reference, Recursive Functions

7. Arrays and Strings **(5 hours)**
- 7.1. Defining an Array
- 7.2. One-dimensional Arrays
- 7.3. Multi-dimensional Arrays
- 7.4. Strings and string manipulation
- 7.5. Passing Array and String to function

8. Structures **(4 hours)**
- 8.1. Introduction

8.2. Processing a Structure
8.3. Arrays of Structures
8.4. Arrays within Structures
8.5. Structures and Function

9. Pointers **(4 hours)**

9.1. Introduction
9.2. Pointer declaration
9.3. Pointer arithmetic
9.4. Pointer and Array
9.5. Passing Pointers to a Function
9.6. Pointers and Structures

10. Data Files **(5 hours)**

10.1. Defining opening and closing a file
10.2. Input/Output operations on Files
10.3. Error handling during input/output operations

11. Introduction to other Programming Languages
(4 hours)

11.1. FORTRAN
11.2. C++
11.3. Java
11.4. C#

Practical

- Minimum 7 lab works on programming with C should be done individually which should include at least followings: (30 marks out of 50 marks)
    1. Input/output operations
    2. Control statements
    3. User defined functions
    4. Arrays & strings
    5. Pointers
    6. Structure and union
    7. Data files
- Student (maximum 4 persons in a group) should submit a mini project at the end of course. (20 marks out of 50 marks)

References:

1. Kelly & Pohl, “A Book on C”, Benjamin/Cumming
2. Brian W. Keringhan& Dennis M. Ritchie, “The ‘C’ Programming Language”, PHI
3. DayaSagarBaral, DiwakarBaral and Sharad Kumar Ghimire “The Secrets of C Programming Language”, Bhundipuran Publication
4. Bryons S. Gotterfried, “Programming with C”, TMH
5. YashavantKanetkar, “Let Us C”, BPB
6. Alexis Leon, Mathews Leon, “Fundamentals of Information Technology”, Leon Press and Vikas Publishing House

Evaluation Scheme

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the course is as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 3	All	16
2	4 & 5	All	16
3	6 & 7	All	16
4	8 & 9	All	16
5	10 & 11	All	16
Total			80

ENGINEERING CHEMISTRY
SH 403

Lecture : 3 **Year : I**
Tutorial : 1 **Part : I**
Practical : 3

Course Objective:

To develop the basic concepts of Physical Chemistry, Inorganic Chemistry and Organic Chemistry relevant to problems in engineering.

1. Electro-chemistry and Buffer **(6 hours)**

1.1. Electro-chemical cells
1.2. Electrode Potential and Standard Electrode Potential
1.3. Measurement of Electrode Potential
1.4. Nernst equation
1.5. EMF of Cell
1.6. Application of Electrochemical and Electrolytic cells
1.7. Electrochemical Series and its Application
1.8. Buffer: its type and mechanism
1.9. Henderson's equation for pH of buffer and related problems
1.10. Corrosion and its type
1.11. Factors influencing corrosion
1.12. Prevention of corrosion

2. Catalyst **(4 hours)**

2.1. Introduction
2.2. Action of Catalyst (Catalytic Promoters and Catalytic Poisons)
2.3. Characteristics of Catalyst
2.4. Types of Catalyst
2.5. Theories of Catalysis
2.6. Industrial Applications of Catalysts

3. Environmental Chemistry **(5 hours)**

3.1. Air Pollution
3.2. Air Pollutants i) gases SOx,NOx,CO,CO2,O3 and hydrocarbons ii) particulates dust, smoke and fly ash
3.3. Effects of Air Pollutants on human beings and their possible remedies
3.4. Ozone depletion and its photochemistry
3.5. Water Pollution (Ref of surface water and pound water)
3.6. Water Pollutants (Ref of surface water) their adverse effect and remedies
3.7. Soil pollution
3.8. Pollutants of soil their adverse effects and possible remedies

4. Engineering Polymers **(6 hours)**

4.1. Inorganic polymers
4.2. General properties of inorganic polymers
4.3. Polyphosphazines
4.4. Sulpher Based Polymers
4.5. Chalcogenide Glasses
4.6. Silicones
4.7. Organic Polymers

4.8. Types of Organic Polymers
4.9. Preparation and application ofi) Polyurethane ii) Polystyrene iii) Polyvinylchloride iv) Teflonv) Nylon 6,6 and vi) Bakelite vii) Epoxy Resin viii) Fiber ReinforcedPolymer
4.10. Concept of bio-degradable, non-biodegradable and conductingpolymers

5. 3-d Transition elements and their applications **(5 hours)**

5.1. Introduction
5.2. Electronic Configuration
5.3. Variable oxidation states
5.4. Complex formation tendency
5.5. Color formation
5.6. Magnetic properties
5.7. Alloy formation
5.8. Applications of 3-d transition elements

6. Coordination Complexes **(5 hours)**

6.1. Introduction
6.2. Terms used in Coordination Complexes
6.3. Werner's Theory Coordination Complexes
6.4. Sidgwick's model and Sidgwick's effective atomic number rule
6.5. Nomenclature of coordination compounds (Neutral type, simple cationand complex anion and complex cation and imple anion type)
6.6. Valence Bond Theory of Complexes
6.7. Application of valence bond theory in the formation of i) TetrahedralComplexesii) Square planar Complexes and iii) Octahedral Complexes
6.8. Limitations of Valence Bond Theory
6.9. Applications of Coordination Complexes

7. Explosives **(3 hours)**

7.1. Introduction
7.2. Types of explosives: Primary, Low and High explosives
7.3. Preparation and application of TNT, TNG, Nitrocellulose and Plasticexplosives

8. Lubricants and Paints **(2 hours)**

8.1. Introduction
8.2. Function of Lubricants
8.3. Classification of Lubricants (Oils, Greases and Solid)
8.4. Paints
8.5. Types of Paint
8.6. Application of Paints

9. Stereochemistry **(4 hours)**

9.1. Introduction
9.2. Geometrical Isomerism (Cis Trans Isomerism) Z and E concept ofGeometrical Isomerism
9.3. Optical Isomerism with reference to two asymmetrical carbon centermolecules
9.4. Terms Optical activity, Enantiomers, Diastereomers, Mesostructures,Racemic mixture and Resolution

10. Reaction Mechanism in Organic reactions **(4 hours)**

10.1. Substitution reaction
10.2. Types of substitution reaction SN1 and SN2

10.3. Elimination reaction
10.4. Types of elimination reaction El and E2
10.5. Factors governing SN1, SN2, El and E2 reaction mechanism path

References:

1. Jain and Jain, "Engineering Chemistry", DhanpatRai Publishing Co.
2. ShashiChawala, "A Text Book of Engineering Chemistry", DhanpatRaiPublishing Co.
3. J. D. Lee, "A New Concise Inorganic Chemistry", Wiley India Pvt. Limited.
4. Marron and Prutton, "Principles of Physical Chemistry", S. Macmillan and Co.Ltd.
5. Bahl and Tuli, "Essential of Physical Chemistry", S. Chand and Co. Ltd.
6. Satya Prakash and Tuli, "Advanced Inorganic Chemistry Vol 1 and 2", S.Chand and Co. Ltd
7. Morrison and Boyd, "Organic chemistry", …………
8. MotiKajiSthapit, "Selected Topics in Physical Chemistry", TalejuPrakashan,Kathmandu.
9. Peavy, Rowe and Tchobanoglous, "Environmental Engineering", McGraw-Hill,New York.
10. R. K. Sharma, B. Panthi and Y. Gotame, "Textbook of Engineering Chemistry",Athrai Publication.

Practical:

1. Compare the alkalinity of different water samples by double indicator method 6 Periods
2. Determine the temporary and permanent hardness of water by EDTAComplexo-metric method 3 Periods
3. Determine residual and combined chlorine present in the chlorinated sample ofwater by Iodometric method 6 Periods
4. Prepare organic polymer nylon 6,6/ Bakelite in the laboratory 3 Periods
5. Determine the pH of different sample of buffer solution by universal indicatormethod 6 Periods
6. Prepare inorganic complex in the laboratory 3 Periods
7. Determine surface tension of the given detergent solution and compare itscleansingpower with other detergent solutions 6 Periods
8. Construct an electrochemical cell in the laboratory and measure the electrodepotential of it 3 Periods
9. Estimate the amount of iron present in the supplied sample of ferrous salt usingstandard potassium permanganate solution (redox titration) 6 Periods

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluationscheme for the question will be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1 & 7	All	16
2	2 & 3	All	16
3	4 & 8	All	16
4	5 & 6	All	16
5	9 & 10	All	16
Total			80

FUNDAMENTALS OF THERMODYNAMICS AND HEAT TRANSFER
ME 402

Lectures : 3 **Year : I**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objective:

To develop basic concepts, laws of thermodynamics and heat transfer and their applications.

1. Introduction (3 hours)

- 1.1. Definition and Scope of Engineering Thermodynamics
- 1.2. Value of energy to society
- 1.3. Microscopic versus Macroscopic Viewpoint
- 1.4. Concepts and Definitions
  - 1.4.1. System, Surroundings, Boundary and Universe; Closed Systems, Open Systems, and Isolated Systems
  - 1.4.2. Thermodynamic Properties: Intensive, Extensive and Specific Properties
  - 1.4.3. Thermodynamic Equilibrium
  - 1.4.4. Thermodynamic State
  - 1.4.5. Thermodynamic Process, Cyclic Process, Quasi-equilibrium Process, Reversible and Irreversible Process
- 1.5. Common Properties: Pressure, Specific Volume, Temperature
- 1.6. Zeroth Law of Thermodynamics, Equality of Temperature

2. Energy and Energy Transfer (3 hours)

- 2.1. Energy and its Meaning
- 2.2. Stored Energy and Transient Energy; Total Energy
- 2.3. Energy Transfer
  - 2.3.1. Heat Transfer
  - 2.3.2. Work Transfer
- 2.4. Expressions for displacement work transfer
- 2.5. Power

3. Properties of Common Substances (6 hours)

- 3.1. Pure Substance and State Postulate
- 3.2. Ideal Gas and Ideal Gas Relations
- 3.3. Two Phase (Liquid and Vapor) Systems: Phase Change; Subcooled Liquid, Saturated Liquid, Wet Mixture, Critical Point, Quality, Moisture Content, Saturated Vapor and Superheated Vapor
- 3.4. Properties of Two Phase Mixtures
- 3.5. Other Thermodynamic Properties: Internal Energy, Enthalpy, and Specific Heats
- 3.6. Development of Property Data: Graphical Data Presentation and Tabular Data Presentation

4. First Law of Thermodynamics (9 hours)

- 4.1. First Law of Thermodynamics for Control Mass; First Law of Thermodynamics for Control Mass Undergoing Cyclic Process
- 4.2. First Law of Thermodynamics for Control Volume
- 4.3. Control Volume Analysis: Steady State Analysis and Unsteady State Analysis
- 4.4. Control Volume Application: Steady and Unsteady Work Applications and Steady and Unsteady Flow Applications

4.5. Other Statements of the First Law

5. Second Law of Thermodynamics **(9 hours)**

5.1. Necessity of Formulation of Second Law
5.2. Entropy and Second Law of Thermodynamics for an Isolated System
5.3. Reversible and Irreversible Processes
5.4. Entropy and Process Relation for an Ideal Gases and Incompressible Substances
5.5. Control Mass Formulation of Second Law
5.6. Control Volume Formulation of Second Law
5.7. Isentropic Process for an Ideal Gas and for an Incompressible Substances
5.8. Carnot Cycle, Heat Engine, Heat Pump and Refrigerator
5.9. Kelvin-Planck and Clausius Statements of the Second Law of Thermodynamics and their Equivalence

6. Thermodynamic Cycles **(9 hours)**

6.1. Classification of Cycles
6.2. Air Standard Brayton Cycle
6.3. Rankine Cycle
6.4. Internal Combustion Cycles
    6.4.1 Air standard Analysis
    6.4.2 Air Standard Otto Cycle
    6.4.3 Air Standard Diesel Cycle
6.5. Vapor Compression Refrigeration Cycle

7. Introduction to Heat Transfer **(6 hours)**

7.1. Basic Concepts and Modes of Heat Transfer
7.2. One dimensional steady state heat conduction through a plane wall
7.3. Radial steady state heat conduction through a hollow cylinder
7.4. Heat flow through composite structures
    7.4.1. Composite Plane Wall
    7.4.2. Multilayer tubes
7.5. Electrical Analogy for thermal resistance
7.6. Combined Heat Transfer and Overall Heat Transfer Coefficient for Plane Wall and Tube
7.7. Nature of Convection; Free and Forced Convection
7.8. Heat Radiation, Stefan's Law, Absorptivity, Reflectivity and Transmissivity; Black Body, White Body and Gray Body

Practical:

1. Temperature Measurements
2. Experiment related to first law
3. Heat Pump
4. Heat Conduction
5. Heat Radiation

References:

1. M. C. Luintel, “Fundamentals of Thermodynamics and Heat Transfer”, Athrai Publication (P) Limited.
2. R. Gurung, A. Kunwar& T. R. Bajracharya, “Fundamentals of Engineering Thermodynamics and Heat Transfer”, Asmita Books Publishers and Distributors (P) Limited.

3. J. R. Howell & R. O. Buckius, “Fundamentals of Engineering Thermodynamics", McGraw Hill Publishers
4. V. Wylen, Sonntag &Borgnakke, “Fundamentals of Thermodynamics”, John Wiley & Sons, Inc.
5. M. J. Moran & H. N. Shapiro, “Fundamentals of Engineering Thermodynamics", John Wiley & Sons, Inc.
6. Y. A. Cengel& M.A. Boles, "Thermodynamics: An Engineering Approach", McGraw-Hill.
7. J. P. Holman, "Heat Transfer", McGraw-Hill
8. Y. A. Cengel, "Heat Transfer: A Practical Approach", McGraw-Hill.

Evaluation Scheme:
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 3	All	16
2	2 & 7	All	16
3	4	All	16
4	5	All	16
5	6	All	16
Total			80

Syllabus

Year - II, Part - I

Bachelors of **Aerospace Engineering**

Department of Mechanical Engineering

Institute of Engineering

Pulchowk Campus

Tribhuvan University

Date: 31/02/2075

ENGINEERING MATHEMATICS III
SH 501

Lecture : 3 **Year : II**
Tutorial : 2 **Part : I**
Practical : 0

Course Objective:

To round out the students' preparation for more sophisticated applications with an introduction to linear algebra, Fourier series, Laplace Transforms, integral transformation theorems and linear programming.

1. Determinants and Matrices **(11 hours)**

1.1. Determinant and its properties
1.2. Solution of system of linear equations
1.3. Algebra of matrices
1.4. Complex matrices
1.5. Rank of matrices
1.6. System of linear equations
1.7. Vector spaces
1.8. Linear transformations
1.9. Eigen value and Eigen vectors
1.10. The Cayley-Hamilton theorem and its uses
1.11. Diagonalization of matrices and its applications

2. Line, Surface and Volume Integrals **(12 hours)**

2.1. Line integrals
2.2. Evaluation of line integrals
2.3. Line integrals independent of path
2.4. Surfaces and surface integrals
2.5. Green's theorem in the plane and its applications
2.6. Stoke's theorem (without proof) and its applications
2.7. Volume integrals; Divergence theorem of Gauss (without proof) and its applications

3. Laplace Transform **(8 hours)**

3.1. Definitions and properties of Laplace Transform
3.2. Derivations of basic formulae of Laplace Transform
3.3. Inverse Laplace Transform: Definition and standard formulae of inverse Laplace Transform
3.4. Theorems on Laplace transform and its inverse
3.5. Convolution and related problems
3.6. Applications of Laplace Transform to ordinary differential equations

4. Fourier Series **(5 hours)**

4.1. Fourier Series
4.2. Periodic functions
4.3. Odd and even functions
4.4. Fourier series for arbitrary range
4.5. Half range Fourier series

5. Linear Programming **(9 hours)**

5.1. System of Linear Inequalities in two variables
5.2. Linear Programming in two dimensions: A Geometrical Approach

5.3. A Geometric introduction to the Simplex method
5.4. The Simplex method: Maximization with Problem constraints of the form “≤”
5.5. The Dual: Maximization with Problem Constraints of the form “≥”
5.6. Maximization and Minimization with mixed Constraints. The two- phase method (An alternative to the Big M Method)

References:

1. S. K. Mishra, G. B. Joshi, V. Parajuli, "Advance Engineering Mathematics", Athrai Publication.
2. E. Kreszig, "Advance Engineering Mathematics", Willey, New York.
3. M.M Gutterman and Z.N.Nitecki, "Differential Equation, a First Course", Saunders, New York.

Evaluation Scheme

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1	1.1 to 1.8	16
2	1	1.9 to 1.11	16
	2	2.1 to 2.4	
3	2	2.5 to 2.7	16
	3	3.1 to 3.2	
4	3	3.3 to 3.6	16
	4	4.1 to 4.3	
5	4	4.4 to 4.5	16
	5	All	
Total			80

FLUID MECHANICS
ME 554

Lecture : 3 **Year : II**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objective:
To provide basic concept of fluid mechanics and its application for solving basic engineering problems.

1. Definition and Analysis method **(2 hours)**
- 1.1 Definition and Properties of a Fluid
- 1.2 Analysis Method
  - 1.2.1 System and Control Volume,
  - 1.2.2 Differential vs Integral Approach,
  - 1.2.3 Description – Lagrangian and Eulerian

2. Fluid Statics **(3 hours)**
- 2.1 Pressure Intensity at a Point
- 2.2 Pressure Variations in a Fluid
- 2.3 Unite of Pressure
- 2.4 Absolute and Gage Pressure
- 2.5 Manometers
- 2.6 Forces on Plane and Curve Surface
- 2.7 Buoyancy and Stability

3. Kinematics of Fluid Flow **(5 hours)**
- 3.1 Description of Fluid Flow: 1D, 2D and 3D Flow
- 3.2 Circulation and Vorticity
- 3.3 Rotational and Irrotational Flow
- 3.4 Equation of Stream Line
- 3.5 Velocity Potential
- 3.6 Stream Function
- 3.7 Acceleration of a Fluid Particle

4. Basic Equations for Fluid Flow **(8 hours)**
- 4.1 Continuity Equations
  - 4.1.1 Rectangular and Cylindrical Coordinate Systems
- 4.2 Momentum Equation and Applications
  - 4.2.1 Elbow reactions, jet propulsions
  - 4.2.2 Fixed and moving vanes, hydraulic jump
- 4.3 Navier-Stokes Equation: Newtonian Fluid
- 4.4 Bernoulli's Equation and Applications, Flow from a tank, Venturi Flow, Syphon Flow

5. Dimensional Analysis and Dynamic Similitude **(3 hours)**
- 5.1 Units and Dimensions
- 5.2 Non-dimensionalizing basic Differential Equation and Dimensionless Numbers
- 5.3 Formation of Dimensionless Equations by Buckingham's Method
- 5.4 Dynamic Similitude Model Studies
- 5.5 Incomplete Similarities

6. Viscous Effects **(10 hours)**

6.1 One Dimensional Laminar Flow; Relationship between shear stress and velocity gradient
6.2 Laminar Flow Between Parallel Plates
6.3 Laminar Flow in Circular Tubes; Reynolds number, velocity profile
6.4 Laminar and Turbulent Boundary Layer Flow; Flow over flat plates, drag on immersed bodies
6.5 Frictional Resistance to Flow in Pipes; Darcey-Weisbach equation, friction factor Use of Moody diagram, head loss in pipe flow
6.6 Head Losses; In bends, joint expansions, valves Loss coefficients

7. Flow Measurement (6 hours)

7.1 Measurement of Static Pressure Intensity
7.2 Measurement of Velocity; Pitot tube, Pitot-static tube
7.3 Restriction Flow Meters: Orifice Plate, Flow nozzles, Venturi, Laminar Flow Elements
7.4 Linear Flow meters
7.5 Weir and Notches
7.6 Flow visualization

8. Flow Measurement (5 hours)

8.1 Hydraulic and Energy Grade Lines Systems including reservoirs, pumps and turbines
8.2 Pipe Flow Networks Series and parallel combinations

9. Introduction to Compressible Flow (3 hours)

Practical:

1. Properties of Fluid and Hydrostatics
   i) Measurement of Fluid viscosity and density
   ii) Buoyancy forces, Center of pressure, stability of floating objects
2. Demonstration of the Energy and Momentum Equations
   i) Pressure distribution for flow through a Venturi
   ii) Force developed by a steady impinging jet flow
3. Fluid flow in Piping
   i) Laminar and turbulent flow, friction losses in liquid flow
   ii) Velocity distribution in air duct
4. Calibration of Flow; Orifice, Venturi, Weir
5. Drag on immersed bodies, measurement of lift and drag force on objects of different shapes
6. The Hydraulic Jumps, relating measured jump parameters to Froude number, momentum, continuity and energy equations.

References:

1. Fox, R. W, McDonald, A. T., Pritchard, P. J., “Introduction to Fluid Mechanics”, JohnWiley.
2. Douglas, J. F, Gasiorek, J. M., Swaffield, J. A., “Fluid Mechanics”, Pearson Education.
3. Frank M. White, “Fluid Mechanics”, McGraw-Hill
4. Kumar, D. S., “Fluid Mechanics”, S. K. Katarai and Sons

Evaluation Scheme:
The questions will cover all the chapters of the syllabus. The evaluation scheme willbe as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 3	All	16
2	4	All	16
3	5 & 8	All	16
4	6	All	16
5	7 & 9	All	16
Total			80

FUNDAMENTAL OF AEROSPACE ENGINEERING
AE

Lecture : 3 **Year : II**
Practical : 1.5 **Part : I**

Course Objective:

To provide basic concepts of Aerospace Engineering. Various fields within the field of aerospace engineering.

1. Standard Atmosphere **(2 hours)**

1.1 Derive the formulation for the standard atmosphere, including the various altitude definitions.
1.2 Define pressure, temperature and density altitude.
1.3 Use standard atmosphere tables.
1.4 Perform standard atmosphere calculations

2. Aero/Hydrodynamics **(4 hours)**

2.1 Define viscosity and discuss its implications.
2.2 Calculate the shear stress at a point given a velocity profile.
2.3 Define the Lagrangian and Eulerian viewpoints of a flow field.
2.4 Define the concept of a streamline.
2.5 Apply conservation of mass to a control volume.
2.6 Use Bernoulli's equation to calculate pressures and velocities in a flow field.

3. Wing Geometry **(6 hours)**

3.1 Define common aircraft terminology and geometry.
3.2 Identify basic aircraft types and discuss their features.
3.3 Define and calculate the lift and drag coefficients using NACA data.
3.4 Define and interpret C_L vs. alpha, and C_L vs C_D curves for 2-D wing sections.
3.5 Explain the difference between 2D sections and 3D wings.

4. Performance and Propulsion **(6 hours)**

4.1 Describe the viscous and pressure drag components on a body.
4.2 Define flow separation and explain where it might occur.
4.3 Explain the three types of aerodynamic drag.
4.4 Perform lift and drag calculations on aircraft.
4.5 Perform thrust calculations.
4.6 Define the thrust/power available and thrust/power required flight envelope.
4.7 Describe how this flight envelope changes with altitude, including the ceiling.

5. Aircraft Stability **(6 hours)**

5.1 Define the six degrees of freedom of aircraft motions.
5.2 Define stable, unstable and neutral stability.
5.3 Explain the difference between static and dynamic stability.
5.4 Explain what is meant by static longitudinal stability for aircraft.
5.5 Explain coupling in lateral and directional stability.

6. Structural Theory **(10 hours)**

6.1 Define what is meant by a neutral axis.

6.2 Define stress and strain and their relationship via Hooke's Law.
6.3 Draw a typical stress-strain diagram for brittle and ductile materials and introduce yielding and fracture.
6.4 Calculate the moment of inertia of a beam's cross-section.
6.5 Solve for the stress distribution over a beam's cross-section.
6.6 Define and calculate a section modulus.

7. Aircraft Structure **(4 hours)**

7.1 Describe the function of the primary load carrying members.
7.2 Perform a spar cap sizing example.
7.3 Understand the basic V-n diagram.

8. Space Applications **(7 hours)**

8.1 Discuss the history of space research.
8.2 Define orbital motion including typical spacecraft trajectories and basic orbital maneuvers.
8.3 Define the six orbital elements.
8.4 Understand and be able to apply Kelper's laws of orbits.
8.5 Understand and be able to apply Newtons law of gravitation.

Practical

1. Lab for conceptual design works based on clay model and CAD.
2. Summarized on research article related to current advancement in Aerospace Technologies.

References

1. Flight without Formulae by A.C Kermode, Pearson Education, 10th Edition
2. Mechanics of Flight by A.C Kermode, Pearson Education, 5th Edition
3. Fundamentals of Flight, Shevell, Pearson Education, 2nd Edition
4. Introduction to Flight by Dave Anderson
5. Aircraft systems: Mechanical,Electrical&Avionics subsystems integration by lanmoir, Allen Seabridge.

Evaluation Scheme:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1 & 2	All	16
2	3&4	All	16
3	5	All	16
4	6 & 7	All	16
5	8	All	16
Total			80

Computer Aided Design and Manufacturing
AE

Lecture : 3 **Year : II**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objective:

The course provides an introduction to the fundamentals of drafting and computer-aided design with applications in aircraft and spacecraft design. Students will acquaint with various computer softwares for engineering design and familiarize with various types and designs that can be carried out using CATIA software. Students will be trained for designing of basic aeronautical parts. Basic training on drafting of the part, model and assembly design with the fundamental concepts of analysis of CAD designs. Students will team up with juniors and seniors to work on aerospace engineering design projects.

COURSE OUTLINE:

1. Introduction **(9 hours)**

- 1.1 Introduction to CAD
  - 1.1.1 I/O devices
  - 1.1.2 various graphics standards
- 1.2 Coordinate systems
- 1.3 Geometric Modeling
  - 1.3.1 Introduction
  - 1.3.2 Types of geometric modeling-wire frame- surface and solid modeling
  - 1.3.3 Wireframe entities- types of curves and its mathematical representation - line-circle- ellipse- parabola- Cubic spline- Bezier and B-spline (Only Basic treatment)
  - 1.3.4 Solid modeling entities - Solid modeling techniques- CSG and BREP - Operations performed in CSG and BREP - Extrude- sweep - linear and Nonlinear-revolve

2. Graphic Concepts (2D and 3D) **(9 hours)**

- 2.1 Transformations - translation- scaling- reflection- rotation
  - 2.1.1 Concatenated transformation
  - 2.1.2 Inverse transformation
  - 2.1.3 Hidden line removal - Z-Buffer algorithm- brief description of shading and color rendering techniques
- 2.2 Manipulation and editing of entities
  - 2.2.1 Selection methods – dragging – clippingtrimming- stretching- offsetting-pattern- copying- deleting - regenerating- measuring
  - 2.2.2 Brief description of animation- types and techniques

3. Software Packages and Recent Technology **(9 hours)**

- 3.1 All about popular commercial solid modeling packages
  - 3.1.1 Salient features
  - 3.1.2 Technical comparison- modules and Tools available
  - 3.1.3 Brief outline of Data exchange standards
  - 3.1.4 Brief outline of feature technology

3.1.5 Classification of features- design by features- applications of features- its advantages- and limitations

4. Manufacturing in a competitive environment (9 hours)

4.1 Automation of Manufacturing Process
4.2 Numerical Control
4.3 Industrial Robots
4.4 Sensor Technology
4.5 Application of Simulation in Manufacturing Process
4.5.1 Forging
4.5.2 Casting
4.5.3 Stamping
4.5.4 CNC 3-axis, 4-axis, 5-axis and 7-axis
4.5.5 3D Printing Technologies

5. Analysis (9 hours)

5.1 System Issues
5.2 Types of Software
5.3 Specification and Selection
5.4 Manufacturing data systems
5.5 Data Flow
5.6 CAD/CAM Considerations
5.7 Planning Flexible Manufacturing System (FMS) database

References

1. Ibrahim Zoid., CAD / CAM — Theory and Practice, TMH, 2001.
2. Chairs Mcmahon and Jimmie Browne, CAD/CAM, AddisionWesly, Newyork, 2000
3. Newman and Sproull, R.F., "Principles of interactive Computer Graphics", TMH,1997,
4. Mikell P. Groover, "CAD/CAM," PHI, 1997.

Methods of Instruction

- Lecture/Demonstration
- Lab/Computer Work

Practical

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

Evaluation Scheme:
The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	All	20
2	2& 3	All	20
4	4	All	20
5	5	All	20
Total			80

APPLIED THERMODYNAMICS AND HEAT TRANSFER
AE

Lecture : 3 **Year : II**
Tutorials : 1 **Part : I**
Practical : 3/2

Course Objectives:

To familiarize the students to understand the applied thermodynamics and heat transfer. (Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart permitted)

1 Gas Power Cycle **(10 hours)**

1.1 Air standard cycles-Otto-Diesel-Dual-Work output,
1.2 Efficiency and MEP calculations
- 1.2.1 Comparison of the cycles for same compression ratio and heat addition
- 1.2.2 Same compression ratio and heat rejection, same peak pressure
- 1.2.3 Peak temperature and heat rejection
- 1.2.4 Same peak pressure and heat input
- 1.2.5 Same peak pressure and work output
- 1.2.6 Brayton cycle

2. Reciprocating Air-compressor and Refrigeration Cycles **(10 hours)**

- 2.1 Single acting and double acting air compressors
- 2.2 Work required
- 2.3 Effect of clearance volume
- 2.4 Efficiencies
  - 2.4.1 Volumetric efficiency
  - 2.4.2 Isothermal efficiency
- 2.5 Free air delivery
- 2.6 Fundamentals of refrigeration and C.O.P.
- 2.7 Reversed carnot cycle
- 2.8 Simple vapour compression refrigeration system
- 2.9 T-S, P-H diagrams,
- 2.10 Simple vapour absorption refrigeration system,
- 2.11 Desirable properties of an ideal refrigerant.

3 : Conduction **(10 hours)**

- 3.1 Basic Concepts
- 3.2 Mechanism of Heat Transfer
  - 3.2.1 Conduction,
  - 3.2.2 Convection and
  - 3.2.3 Radiation
- 3.3 General Differential equation of Heat Conduction
  - 3.3.1 Fourier Law of Conduction – Cartesian
  - 3.3.2 One Dimensional Steady State Heat Conduction
  - 3.3.3 Conduction through Plane Wall, Cylinders and Spherical systems
- 3.4 Composite Systems
- 3.5 Conduction with Internal Heat Generation

3.6 Extended Surfaces
3.7 Unsteady Heat Conduction
3.8 Lumped Analysis
3.9 Use of Heislers Chart.

4. Convection **(10 hours)**

4.1 Basic Concepts
4.2 Convective Heat Transfer Coefficients
4.3 Boundary Layer Concept
4.4 Forced Convection
4.4.1 Dimensional Analysis
4.5 External Flow
4.5.1 Flow over Plates,
4.5.2 Cylinders and
4.5.3 Spheres
4.6 Internal Flow
4.7 Laminar and Turbulent Flow
4.8 Flow over Bank of tubes
4.9 Free Convection
4.9.1 Dimensional Analysis –
4.10 Flow over Vertical Plate.

5. Radiation **(5 hours)**

5.1 Basic Concepts, Laws of Radiation
5.1.1 Stefan Boltzman Law
5.1.2 Kirchoff Law
5.1.3 Black Body Radiation
5.1.4 Grey body radiation
5.2 Shape Factor Algebra
5.3 Electrical Analogy
5.4 Radiation Shields
5.5 Introduction to Gas Radiation

Practical:

Lab 1 Conduction Heat Transfer

Verification of Conduction Laws
Drawing of Temperature Profile
Comparison between Thermal Conductivities of Different Types of Materials

Lab 2 Convection Heat Transfer

Free Convection from Different Types of Plates
Force Convection from Different Types of Plates

Lab 3 Radiation Heat Transfer

Relationship between Temperature, Frequency and Wavelength
Reflectivity, Absorptivity and Transmissivity

Lab 4 Boiling Heat Transfer

Mass and Energy Balances

Efficiency
Effects of Mixture on Boiling Heat Transfer

Lab 5 Heat Exchanger

Energy Balance of Different Types of Heat Exchangers
Drawing of Temperature Profiles of Different Types of Heat Exchangers
Effectiveness of Different Types of Heat Exchangers

Lab 6 Fins

Drawing of Temperature Profiles of Different Types of Fins
Heat Dissipation from Different Types of Fins

References:

1. Holman. J.P. “Heat Transfer”, Tata McGraw –Hill, 2003
2. Nag. P.K. ”Basic and applied Thermodynamics” Tata McGraw–Hill Publishing Co. Ltd, New Delhi, 2004
3. Nag. P..K. “ Heat Transfer”, Tata McGraw-Hill, New Delhi, 2002

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1	All	16
2	2	All	18
3	3	All	18
4	4	All	18
5	5	All	10
Total			80

ENGINEERING MECHANICS
ME 502

Lecture : 3 **Year : II**
Tutorial : 1 **Part : I**
Practical : 0

Course Objective:

To provide the fundamental principles, concepts and application of mechanics for solving engineering problems. To become familiar with the analytical/graphical methods for solving problems of mechanics, mainly of dynamics.

1. Virtual Work **(2 hours)**

- 1.1 Definition of Work and Virtual Work
- 1.2 Principal of Virtual Work for a Particle and a Rigid Body
- 1.3 Uses of the Principal of Virtual Work
- 1.4 Virtual Work Done by Moments

2. Kinetics of Particles: Force, Mass and Acceleration **(6 hours)**

- 2.1 Newton's Second Law of Motion
- 2.2 Consistent System of Units
- 2.3 Equations of Motion: Radial and Transverse Components
- 2.4 Dynamic Equilibrium: Inertia Force
- 2.5 Principle of Motion of the Mass Centre
- 2.6 Motion due to a Central Force, Conservation of Momentum
- 2.7 Newton's Law of Gravitation

3. Kinetics of Particles: Work Energy Principles **(4 hours)**

- 3.1 Work Done by a Force
- 3.2 Kinetic Energy of a Particle
- 3.3 Principle of Work and Energy, Applications
- 3.4 Power and Efficiency
- 3.5 Potential Energy
- 3.6 Conservation of Energy

4. Kinetics of Particles: Impulse and Momentum **(6 hours)**

- 4.1 Principle of Impulse and Momentum
- 4.2 Impulsive Motion and Impact
- 4.3 Direct Central Impact
- 4.4 Oblique Central Impact

5. Kinematics of Rigid Bodies **(7 hours)**

- 5.1 Introduction to Plane Kinematics of Rigid Bodies
- 5.2 Translation, Rotation and General Plane Motion
- 5.3 Absolute and Relative Velocity in Plane Motion
- 5.4 Instantaneous Centre of Rotation
- 5.5 Absolute and Relative Acceleration in Plane Motion
- 5.6 Motion Relative to Rotating Axis; Coriolis Acceleration

6. Plane Kinetics of Rigid Bodies: Force, Mass and Acceleration **(8 hours)**

- 6.1 Mass Moment of Inertia
  - 6.1.1 Moment of Inertia of Mass
  - 6.1.2 Radius of Gyration
  - 6.1.3 Parallel Axis Theorem

6.1.4 Mass moment of inertia of Composite Bodies
6.2 Force and Acceleration
6.2.1 Equations of Motion for a Rigid Body
6.2.2 Angular Momentum of a Rigid Body in Plane Motion
6.2.3 Plane Motion of a Rigid Body: D'Alembert's Principle
6.2.4 Application of Rigid Body Motion in the Plane
6.2.5 Constrained Motion in the Plane

7. Plane Motion of Rigid Bodies: Work and Energy Method (4 hours)
7.1 Work Energy Relations
7.2 Work of a Force on a Rigid Body
7.3 Kinetic Energy of a Rigid Body
7.4 Principle of Work and Energy for a Rigid Body
7.5 Acceleration from Work Energy Method

8. Plane Motion of Rigid Bodies: Impulse and Momentum Method (4 hours)
8.1 Impulse and Momentum of a Rigid Body
8.2 Conservation of Angular and Linear Momentum
8.3 Impulsive Motion and Eccentric Impact of Rigid Bodies

9. Lagrangian Dynamics (4 hours)
9.1 Degree of Freedom in mechanical systems and Generalized Coordinates
9.2 D'Alembert's – Lagrange Principle and Lagrange Equations of motion
9.3 Differential equation of motion for a system of particles
9.4 Conservation Theorems

Tutorials
There should be at least one assignment from each chapter and 2 assessment tests during the semester.

References
1. F.P. Beer and E.R. Johnston, "Mechanics for Engineers – Statics and Dynamics", Mc Graw Hill.
2. R.C. Hibbler, "Engineering Mechanics – Dynamics", Pearson, New Delhi.
3. J.C. Jong and B.G. Rogers, "Engineering Mechanics, Statics and Dynamics"- Saunders College Publishing, International Edition
4. Bela I. Sandor, "Engineering Mechanics – Dynamics", Prectice Hall, Inc.,Englewood Cliffs.
5. J.L. Meriam.,"Engineering Mechanics – Statics and Dynamics", John Wiley and Sons.

Evaluation Scheme:
There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	2 & 3	All	16
2	4 & 7	All	18
3	5	All	18
4	6	All	18
5	1, 8 & 9	All	10
Total			80

Syllabus

Year - II, Part - II

Bachelors of **Aerospace Engineering**

Department of Mechanical Engineering

Institute of Engineering

Pulchowk Campus

Tribhuvan University

Date: 31/02/2075

PROBABILITY AND STATISTICS
SH 552

Lecture : 3 **Year : II**
Tutorial : 1 **Part : II**
Practical : 0

Course Objective:

To provide students practical knowledge of the principles and concept of probabilityand statistics and their application in engineering field.

1. Descriptive statistics and Basic probability (6 hours)

1.1. Introduction to statistics and its importance in engineering
1.2. Describing data with graphs (bar, pie, line diagram, box plot)
1.3. Describing data with numerical measure (Measuring center, measuring variability)
1.4. Basic probability, additive Law, Multiplicative law, Baye's theorem.

2. Discrete Probability Distributions (6 hours)

2.1. Discrete random variable
2.2. Binomial Probability distribution
2.3. Negative Binomial distribution
2.4. Poison distribution
2.5. Hyper geometric distribution

3. Continuous Probability Distributions (6 hours)

3.1. Continuous random variable and probability densities
3.2. Normal distribution
3.3. Gama distribution
3.4. Chi square distribution

4. Sampling Distribution (5 hours)

4.1. Population and sample
4.2. Central limit theorem
4.3. Sampling distribution of sample mean
4.4. Sampling distribution of sampling proportion

5. Inference Concerning Mean (6 hours)

5.1. Point estimation and interval estimation
5.2. Test of Hypothesis
5.3. Hypothesis test concerning One mean
5.4. Hypothesis test concerning two mean
5.5. One way ANOVA

6. Inference concerning Proportion (6 hours)

6.1. Estimation of Proportions
6.2. Hypothesis concerning one proportion
6.3. Hypothesis concerning two proportion
6.4. Chi square test of Independence

7. Correlation and Regression (6 hours)

7.1. Correlation
7.2. Least square method
7.3. An analysis of variance of Linear Regression model
7.4. Inference concerning Least square method
7.5. Multiple correlation and regression

8. Application of computer on statistical data computing (4 hours)

8.1. Application of computer in computing statistical problem. eq scientific calculator, EXCEL, SPSS , Matlabetc

References:

1. Richard A. Johnson, "Probability and Statistics for Engineers", Miller and Freund's publication.
2. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences",Brooks/Cole publishing Company, Monterey, California.
3. Richard I. Levin, David S Rubin, "Statisticsfor Management", PrenticeHallpublication.
4. Mendenhall Beaver Beaver, "Introduction Probability and statistics ", ThomsonBrooks/Cole.

Evaluation scheme

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	All	16
	2	2.1 to 2.2	
2	2	2.3 & 2.5	16
	3	All	
3	4 & 5	All	16
4	6	All	16
	7	7.1 and 7.5	
5	7	7.2 to 7.4	16
	8	All	
Total			80

CONTROL SYSTEM
EE602

Theory : 3 **Year : II**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:

To present the basic concepts on analysis and design of control system and to apply these concepts to typical physical processes.

1. Control System Background **(2 hours)**

1.1 History of control system and its importance
1.2 Control system: Characteristics and Basic features
1.3 Types of control system and their comparison

2. Component Modeling **(6 hours)**

2.1 Differential equation and transfer function notations
2.2 Modeling of Mechanical Components: Mass, spring and damper
2.3 Modeling of Electrical components: Inductance, Capacitance, Resistance, DC and AC motor, Transducers and operational amplifiers
2.4 Electric circuit analogies (force-voltage analogy and force- current analogy)
2.5 Linearized approximations of non-linear characteristics

3. System Transfer Function and Responses **(6 hours)**

3.1 Combinations of components to physical systems
3.2 Block diagram algebra and system reduction
3.3 Signal flow graphs
3.4 Time response analysis:
3.4.1 Types of test signals (Impulse, step, ramp, parabolic)
3.4.2 Time response analysis of first order system
3.4.3 Time response analysis of second order system
3.4.4 Transient response characteristics
3.5 Effect of feedback on steady state gain, bandwidth, error magnitude and system dynamics

4. Stability **(4 hours)**

4.1 Introduction of stability and causes of instability
4.2 Characteristic equation, root location and stability
4.3 Setting loop gain using Routh-Hurwitz criterion
4.4 R-H stability criterion
4.5 Relative stability from complex plane axis shifting

5. Root Locus Technique **(7 hours)**

5.1 Introduction of root locus
5.2 Relationship between root loci and time response of systems
5.3 Rules for manual calculation and construction of root locus
5.4 Analysis and design using root locus concept
5.5 Stability analysis using R-H criteria

6. Frequency Response Techniques **(6 hours)**

6.1 Frequency domain characterization of the system
6.2 Relationship between real and complex frequency response
6.3 Bode Plots: Magnitude and phase

6.4 Effects of gain and time constant on Bode diagram
6.5 Stability from Bode diagram (gain margin and phase margin)
6.6 Polar Plot and Nyquist Plot
6.7 Stability analysis from Polar and Nyquist plot

7. Performance Specifications and Compensation Design (10 hours)

7.1 Time domain specification
7.1.1 Rise time, Peak time, Delay time, settling time and maximum overshoot
7.1.2 Static error co-efficient
7.2 Frequency domain specification
7.2.1 Gain margin and phase margin
7.3 Application of Root locus and frequency response on control system design
7.4 Lead, Lag cascade compensation design by Root locus method.
7.5 Lead, Lag cascade compensation design by Bode plot method.
7.6 PID controllers

8. State Space Analysis (4 hours)

8.1 Definition of state -space
8.2 State space representation of electrical and mechanical system
8.3 Conversion from state space to a transfer function.
8.4 Conversion from transfer function to state space.
8.5 State-transition matrix.

Practical:

1. To study open loop and closed mode for d.c motor and familiarization with differentcomponents in D.C motor control module.
2. To determine gain and transfer function of different control system components.
3. To study effects of feedback on gain and time constant for closed loop speed controlsystem and position control system.
4. To determine frequency response of first order and second order system and to gettransfer function.
5. Simulation of closed loop speed control system and position control system and Verification

References:

1. Ogata, K., “Modern Control Engineering”, Prentice Hall, Latest Edition
2. Gopal. M., “Control Systems: Principles and Design”, Tata McGraw-Hill, LatestEdition.
3. Kuo, B.C., “Automatic Control System”, Prentice Hall, sixth edition.
4. Nagrath&Gopal, “Modern Control Engineering”, New Ages International, LatestEdition

Evaluation scheme:

The question will cover all the chapters of the syllabus. The evaluation scheme willbe as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	All	16
2	3 & 4	All	16
3	5	All	16
4	6 & 8	All	16
5	7	All	16
Total			80

STRENGTH OF MATERIALS
ME 552

Lecture : 3 **Year : II**
Tutorials : 1 **Part : II**
Practical : 3/2
Course Objective:
To analyze and solve problems related to different types of stress and strain and to design basic components of structure and machines on the basis of stiffness, strength and stability.

1. Introduction (2 hours)
1.1 Types of Stresses and strains
1.2 Normal stress, shear stress, bearing stress
1.3 Normal strain, shear strain
1.4 Ultimate stress, allowable stress, factor of safety

2. Stress and strain – axial loading (6 hours)
2.1 Stress – strain diagram
2.2 Hooke's law, modulus of elasticity
2.3 Deformation under axial load
2.4 Temperature effects
2.5 Poisson’s Ratio
2.6 Multi-axial loading, Generalized Hooke’s Law
2.7 Bulk Modulus
2.8 Shearing Strain
2.9 Relationship among modulus of elasticity, shear stress and Poisson’s ratio
2.10 Stress Concentration and Plastic Deformation
2.11 Statically Indeterminate problems

3. Pure Bending (5 hours)
3.1 Introduction of pure or simple bending
3.2 Deformation of a symmetric member in pure bending in elastic range.
(Relationship between transverse loads, bending moment and bending stresses, position of neutral axis and neutral layer)
3.3 Beams with composite section.
3.4 Stress concentration, plastic deformation
3.5 Eccentric axial loading
3.6 Unsymmetrical loading.

4. Torsion (5 hours)
4.1 Introduction Torque, Shaft, Torsion
4.2 Stress and deformation in a uniform shaft in elastic range
4.3 Torsion moment diagram.
4.4 Torsion formula for circular cross-section
4.5 Statically Indeterminate Shaft
4.6 Design of Transmission of shaft (by strength and stiffness)
4.7 Comparison between hollow and solid shaft.
4.8 Shafts in series and parallel
4.9 Composite shafts
4.10 Stress concentrations in circular shafts.

5. Transverse loading (3 hours)

5.1 Basic assumptions and distribution of normal stress.
5.2 Relationship between shear stress and shear force in a beam.
5.3 Distribution of Shear stress in common beam sections.

6. Transformation of stress and strain (6 hours)

6.1 Uniaxial stress system, biaxial stress system, pure shear stress system.
6.2 General plane stress system, principal stresses, maximum shearing stress, principal planes
6.3 Graphical method: Mohr's circle for plane stress
6.4 Application to three- dimensional state of stress
6.5 Yield criteria for ductile and brittle material.

7. Deflection of Beams by Integration Method (6 hours)

7.1 General deflection equation for beams.
7.2 Deflection equation for beams with different end conditions.
7.3 Method for superposition.
7.4 Deflection in statically indeterminate beams.
7.5 Direct determination of the elastic curve from the load-distribution.

8. Deflection of Beams by Moment- area Method (4 hours)

8.1 Moment- Area Theorems.
8.2 Application to symmetrical structure and symmetrical loading, unsymmetrical structure and symmetrical loading, symmetrical structure and unsymmetrical loading.
8.3 Maximum deflection in beams.

9. Design of Beams and shafts (5 hours)

9.1 Basic Consideration for the design of prismatic beams (for ductile, brittle material and for short and long beam)
9.2 Principal stresses in beams
9.3 Design of prismatic beams

10. Columns (3 hours)

10.1 Introduction: Strut, column, buckling load
10.2 Euler's formula for different end conditions.
10.3 Design of columns under central and eccentric loading.

Practical:

1. Material Properties in simple bending and compression test.
2. Torsion test: Behavior of ductile and brittle materials in torsion, shear modulus
3. Stresses and strains in thin wall cylinders
4. Column behavior and buckling: effect of end conditions on buckling load of beams.
5. Beam reactions: Relationship between deflection and transverse load, end conditions, Young's modulus of elasticity, moment of inertia

References:

1. F.P. Beer and E. R. Johnson, " Mechanics of Materials", McGraw Hill,
2. R.K. Rajput, " Strength of Materials", S. Chand & Co. Ltd.,
3. E. P. Popov, "Engineering Mechanics of Solids", Prentice Hall Inc., Englewood Cliffs, N. J.

Evaluation Scheme:
The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	All	16
2	3 & 4	All	16
3	5 & 6	All	16
4	7 & 8	All	16
5	9 & 10	All	16
Total			80

THEORY OF MECHANISM AND MACHINE I
ME653

Lecture : 3 **Year : II**
Tutorial : 3/2 **Part : II**
Practical : 0

Course Objectives:

To make students understand about different mechanism used in devices or machines and make them able to do complete analysis of mechanism (including linkages, gears, gear trains, cams and followers).

1. Introduction **(2 hours)**

1.1. Introduction to the study of mechanisms
1.2. Basic definitions & descriptions
1.3. Mechanism configurations, links, chains, inversions
1.4. Transmission of motion
1.5. Mobility, Degree of freedom

2. Linkages and Mechanisms **(4 hours)**

2.1. Position Analysis of the four-bar mechanism
2.2. Four-bar linkage motion and Grashoff's law
2.3. Linkage position analysis; loop closure equations & iterative methods
2.4. Introduction to different mechanism : Slider crank, Scotch Yoke, Quick return, toggle, Oldham coupling & Hooke's Coupling, Straight line, Chamber wheel, constant velocity universal joint, intermittent motion, mechanical computing, etc. mechanisms.
2.5. Synthesis concepts

3. Cams and Followers **(6 hours)**

3.1. Classification of cams and nomenclature
3.2. Graphical cam layout;
3.3. Disk cam with flat-faced follower
3.4. Disk cam with Radial or Offset follower
3.5. Standardized Follower Displacement or Lift curves
3.6. Analytical Cam Design; Disk cam with flat-faced follower: Disk cam with Radial or Offset follower: Disc cam with Oscillating Roller follower
3.7. Other cam layouts
3.8. Cam production methods

4. Spur Gears **(6 hours)**

4.1. Introduction to Involute spur gears
4.2. Geometry of Involutes
4.3. Characteristics of Involute Tooth Action
4.4. Standardization of Gears; Metric system
4.5. Interference of Involute Gears
4.6. Numbers of teeth to avoid interference
4.7. Determining backlash in Involute gears
4.8. Non-standard Spur gears; extended center distance system
4.9. Methods of gear production

5. Bevel, Helical and Worm Gears **(5 hours)**

5.1. Theory of straight Bevel gears
5.2. Bevel Gear tooth proportions and geometrical details

5.3. Spiral and Hypoid gears
5.4. Theory of helical gears & tooth geometry
5.5. Parallel and crossed shafts for helical gears
5.6. Worm gearing

6. Simple and Planetary gear trains (5 hours)

6.1. Theory of Planetary Gear Trains
6.2. Speed Ratios; Formula and Tabular Methods
6.3. Applications
6.4. Assembly of Planetary gear trains

7. Kinematic Analysis of Mechanisms (9 hours)

7.1. General Plane Motion Representation
7.2. Relative Motion Velocity Analysis; Velocity Polygons; Graphical or Vector algebra solutions
7.3. Instantaneous centers of velocity
7.4. Kennedy's theorem
7.5. Velocities by Instantaneous centers
7.6. Relative motion acceleration analysis; Acceleration Polygons; Graphical or Vector algebra solutions; Corilis acceleration applications
7.7. Motion analysis by vector mathematics; Velocity analysis, Acceleration Analysis, Coriolis Acceleration Application
7.8. Analysis by Complex Numbers; Loop Closure Equation for Geometrical Layout, Kinematic Analysis by Complex Numbers Application

8. Force Analysis of Mechanisms (8 hours)

8.1. Centrifugal Force, Inertia Force and Inertia Torque
8.2. Methods of Force Analysis – Introduction
8.3. Forces on Gear Teeth- spur/bevel & helical gears
8.4. Force analysis on cams & followers
8.5. Superposition Force Analysis Methods, Graphical or Analytical
8.6. Linkage Force by Matrix Methods
8.7. Linkage Force by Method of Virtual Work
8.8. Linkage Force by Complex Number Method
8.9. Applications and Examples

References:

1. H.H. Mabie and C. F. Reinholtz, "Mechanism and Dynamics of Machinery", Wiley.
2. J.S. Rao & R.V. Dukkipati Mechanisms and Machine Theory, New Age International (P) Limited..
3. J.E. Shigley and J.J. Uicker, Jr., " Theory of Machines and Mechanisms", McGraw Hill.
4. B. Paul, "Kinematics and Dynamics of Planar Machinery", Prentice Hall.
5. C. E. Wilson, J.P. Sadler and W.J. Michels, "Kinematics and Dynamics of Machinery", Harper Row.

Evaluation Scheme:

There will be questions covering all the chapters of the syllabus. The evaluation scheme for the questions will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	All	16
	3	3.1 & 3.10	
2	3	3.2 to 3.9	16
	4	All	
3	5 & 6	All	16
4	7	All	16
5	8	All	16
Total			80

AERODYNAMICS
AE

Lecture : 3 **Year : II**
Tutorial : 2 **Part : II**
Practical : 3/2

Course Objectives:

This course builds on the student's background in Fluid Mechanicsto deal primarily with internal and external flows (low-speed andhigh speed) relevant to aerospace applications. Studentsareexpected to be able to analyse flows past airfoils, wings as well asnozzles and diffusers which form the basic building blocks of an airplane.

1. Introduction **(7 hours)**

1.1 Lift, drag, moment and related coefficients;
1.2 Vector operations (review);
1.3 Conservation equations (mass, momentum and energy);
1.4 Streamlines, streaklines and pathlines;
1.5 Velocity potential and stream function

2. Inviscid, Incompressible flow **(6 hours)**

2.1 Bernoulli's equation, low-speed wind tunnel flows;
2.2 Governing equations and boundary conditions;
2.3 Elementary flows (uniform, sources, sinks and vortex);
2.4 Ideal lifting flow past a circular cylinder,
2.5 Kutta-Joukowski theorem and lift generation;
2.6 Source panel method for non-lifting flows;
2.7 d' Alembert's paradox.

3. Incompressible flow over airfoils **(5 hours)**

3.1 Introduction; Kutta Condition;
3.2 Thin airfoil theory (symmetric, cambered);
3.3 Aerodynamic center;
3.4 vortex panel method for lifting flows;
3.5 qualitative picture of viscous flow.

4. Finite Wing Theory **(6 hours)**

4.1 Introduction; Downwash and induced drag;
4.2 Biot-Savart Law and Helmholtz's Theorems;
4.3 Prandtl's lifting line theory;
4.4 Numerical lifting-line method;
4.5 Some practical aspects.

5. Introduction to Compressible flows (Inviscid) **(5 hours)**

5.1 Thermodynamics review;
5.2 Governing equations;
5.3 Compressibility.

6. Normal Shock, Oblique Shock and Expansion Waves **(8 hours)**

6.1 Basic relations; flow over wedges and cones;
6.2 shock interactions; blunt body flow;
6.3 Prandtl-Meyer expansion waves;
6.4 qualitative pitcute of shock wave-boundary layer interaction;

6.5 quasi-one-dimensional flow through nozzles and diffusers.

7. Linearized Theory for Subsonic and Supersonic Flows **(6 hours)**

7.1 Introduction; Velocity potential equation and linearized form;
7.2 Prandtl-Glauert correction;
7.3 Improved corrections;
7.4 Critical Mach number;
7.5 Drag divergence; Supercritical airfoils and area rule.

8. Aspects of hypersonic flows **(2 hours)**

References:

1. Houghton, E.L., and Caruthers, N.B., “Aerodynamics for Engineering students”, Edward Arnold Publishers Ltd., London, 1989.
2. Anderson, J.D., “Fundamentals of Aerodynamics”, MaGraw Hill Book Co., 1999
3. Milne Thomson, L.H., “Theoretical Aerodynamics”, Macmillan, 1985
4. John J Bertin., “Aerodynamics for Engineers”, Pearson Education Inc, 2002
5. Clancey, L J.,” Aerodynamics”, Pitman, 1986
6. Kuethe, A.M and Chow, C.Y, “Foundations of Aerodynamics”, Fifth Edition, John Wiley & Sons, 2000.

Practical

1. Subsonic Wing Tunnel Test of an NACA Airfoil.
2. Implement Vortex Panel Method in MATLAB to Calculate Lift of the NACA airfoil tested in Wind Tunnel.

Evaluation Scheme:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	All	16
2	2 & 3	All	16
3	4	All	16
4	5 & 7	All	16
5	6 & 8	All	16
Total			80

AEROSPACE MATERIALS
AE

Lecture : 4 **Year : II**
Tutorials : 0 **Part : I**
Practical : 3/2

1. Introduction to Materials **(2 hour)**
1.1 Types of Materials
1.2 Relationship among structures, processing and properties
1.3 Material selection for design

2. Atomic Structure, arrangement of atoms **(8 hours)**
2.1 Structure of atom, periodic table, binding energy and bonds
2.2 Atomic arrangements
- 2.2.1 Crystal and amorphous
- 2.2.2 Crystal geometry
- 2.2.3 Unit cell
- 2.2.4 Lattices, points, directions, planes in a unit cell
- 2.2.5 Millers' indices
- 2.2.6 Allotropic and polymorphic transformation

2.3 Imperfections in the atomic arrangement
- 2.3.1 Imperfections
- 2.3.2 Point defects, surface defects, dislocation
- 2.3.3 Deformation by slip and twinning
- 2.3.4 Schmid's Law

2.4 Movement of atoms in materials
- 2.4.1 Fick's First Law
- 2.4.2 Fick's Second Law

3. Mechanical Properties and their tests **(8 hours)**
3.1 Tensile Test
- 3.1.1 Load- Deformation Diagrams
- 3.1.2 Engineering stress-strain diagram for ductile and brittle materials
- 3.1.3 True stress-strain diagram
- 3.1.4 Properties tested from tensile test, temperature effects
- 3.1.5 Brittle behavior and notch effects.

3.2 Hardness Test
- 3.2.1 Main hardness testing methods
- 3.2.2 Brinell, Rockwell, Vickers, Knoop test
- 3.2.3 Microhardness test, Hardness conversion table

3.3 Impact Test
- 3.3.1 Toughness
- 3.3.2 Types of impact test, Charpy and Izod test
- 3.3.3 Significance of Transition - Temperature curve, Notch sensitivity

3.4 Fatigue Test
- 3.4.1 Fatigue failure

3.4.2 S-N curve, Endurance limit, Fatigue strength versus fatigue limit
3.4.3 Preventions

3.5 Creep Test
3.5.1 Creep failure
3.5.2 Creep and stress rupture curve
3.5.3 Effect of temperature and stress level on creep life
3.5.4 Preventions

4. Deforming process for materials (6 hours)

4.1 Cold work
4.1.1 Cold work and its types
4.1.2 Strain Hardening and the stress-strain curve
4.1.3 Properties versus degree of Cold-work
4.1.4 Microstructure and residual stress in cold worked metals

4.2 Treatment after Cold-work
4.2.1 Annealing
4.2.2 Three stages of annealing (recovery, recrystallization and grain growth)

4.3 Hot-work
4.3.1 Hot-work process and its types
4.3.2 Comparison between Hot-work and Cold-work

5. Solidification, Phase Relations and Strengthening Mechanism (7 hours)

5.1 Solidification
5.1.1 Nucleation and grain growth
5.1.2 Dendrite formation
5.1.3 Cooling curve
5.1.4 Under-cooling Cast structure
5.1.5 Solidification defect
5.1.6 Solid solutions, Solid solutions strengthening

5.2 Phase relations and equilibrium
5.2.1 Phase, phase rule
5.2.2 Phase diagram containing three- phase reactions
5.2.3 Lever rule, four important three phase reactions, and Eutectic phase diagram

5.3 Strengthening Mechanism
5.3.1 Alloys strengthening by exceeding solubility limit
5.3.2 Age hardening or precipitation hardening

5.3.3 Residual stress during quenching and heating

6. Iron – Iron Carbide diagram and Heat Treatment of Steels (8 hours)

6.1 Iron – Iron Carbide Diagram
6.1.1 Applications and limitations of Iron– Iron Carbide Diagram
6.1.2 Different mixtures and phases (ferrite, austenite, pearlite, martensite)
6.1.3 Classification of steels and cast iron referring to Iron- Iron Carbide Phase diagram

6.2 Simple Heat Treatments
6.2.1 Annealing and its types (Full annealing, homogenizing, spheroidizing), their method, applications

6.2.2 Normalizing method and its application, comparison between annealing and normalizing.
6.2.3 Quenching (method and application), quenching medium, hardenability,Jominy test, TTT diagram, CCT diagram
6.2.4 Tempering, its types, applications
6.2.5 Different types of surface hardening processes, nitriding, carburizing, cyaniding

7. High Performance Aircraft Materials **(8 hours)**

7.1 Terminology Relating to Aircraft Materials
7.2 Non-Ferrous Alloys
- 7.2.1 Aluminum Alloys
- 7.2.2 Magnesium Alloys
- 7.2.3 Copper Alloys
- 7.3.4 Nickel Alloys
- 7.3.5 Cobalt Alloys
- 7.3.6 Titanium Alloys - Properties and Applications

10.2 Classification of heat resistant materials
10.3 Inconel Monal& K-Monal, Nimonic and Super Alloys
10.4 Identification of Failure Debris

8. Design of High Temperature Super-Alloys **(4 hours)**

8.1 Refractory metals and their alloys
8.2 Design of Turbine Blade Materials
8.3 Thermal Barrier Coating Technology
8.4 Single Crystal Superalloys

9. Composite Materials **(8 hours)**

9.1 Fibers
9.2 Matrix
9.3 Mechanics of Composite Materials
- 9.3.1 Macro Mechanical Behavior of a Lamina
- 9.3.2 Micro-Mechanical Behavior of a Lamina
- 9.3.3 Macro-Mechanical Behavior of a Laminate

10. Environmental Effects **(1 hour)**

10.1 Galvanic and Stress corrosion, Corrosion protection

Practical:

1. Macro examination of metals: Macrography to determine uniformity of composition, method of manufacture, physical defects.
2. Micro examination (Metallography)
   a. Selection and preparation of the specimen.
   b. Application of heat treatment (full annealing, normalizing, quenching, tempering), etching, observation through metallurgical microscope to different specimens of ferrous and non-ferrous alloys.
3. Examination of Failure: Fatigue, Creep

4. Tests: Hardness Test (Brinell, Rockwell, Micro-hardness)
5. Mechanical Testing (tensile, compressive, impact) for ceramics and polymers
6. Strength Testing of Adhesives
7. Literature Review on current aviation materials (Individual topics for each students)

References:

1. Tariq Siddiqui, "Aircraft Materials and Analysis" McGraw-Hill Education, 2014
2. Adrian Mouritz, "Introduction to Aerospace Materials" Woodhead Publishing
3. D. R. Askeland, “The Science and Engineering of Materials”, PWS- Kent Publishing Co., Boston,
4. Westerman Table (IS Standard)

Evaluation Scheme:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	All	16
2	3 & 9	All	16
3	4 & 5	All	16
4	6 & 8	All	16
5	7 & 10	All	16
Total			80

Syllabus

Year - III, Part - I

Bachelors of **Aerospace Engineering**

Department of Mechanical Engineering

Institute of Engineering

Pulchowk Campus

Tribhuvan University

Date: 31/02/2075

NUMERICAL METHODS
SH 603

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3

Course objective:

To introduce numerical methods used for the solution of engineering problems. The course emphasizes algorithm development and programming and application to realistic engineering problems.

1. Introduction, Approximation and errors of computation (4hours)

1.1. Introduction, Importance of Numerical Methods
1.2. Approximation and Errors in computation
1.3. Taylor's series
1.4. Newton's Finite differences (forward, backward, central difference, divided difference)
1.5. Difference operators, shift operators, differential operators
1.6. Uses and Importance of Computer programming in Numerical Methods.

2. Solutions of Nonlinear Equations (5 hours)

2.1. Bisection Method
2.2. Newton Raphson method (two equation solution)
2.3. Regula-Falsi Method, Secant method
2.4. Fixed point iteration method
2.5. Rate of convergence and comparisons of these Methods

3. Solution of system of linear algebraic equations (8 hours)

3.1. Gauss elimination method with pivoting strategies
3.2. Gauss-Jordan method
3.3. LU Factorization
3.4. Iterative methods (Jacobi method, Gauss-Seidel method)
3.5. Eigen value and Eigen vector using Power method

4. Interpolation (8 hours)

4.1. Newton's Interpolation (forward, backward)
4.2. Central difference interpolation: Stirling's Formula, Bessel's Formula
4.3. Lagrange interpolation
4.4. Least square method of fitting linear and nonlinear curve for discrete data and continuous function
4.5. Spline Interpolation (Cubic Spline)

5. Numerical Differentiation and Integration (6 hours)

5.1. Numerical Differentiation formulae
5.2. Maxima and minima
5.3. Newton-Cote general quadrature formula
5.4. Trapezoidal, Simpson's 1/3, 3/8 rule
5.5. Romberg integration
5.6. Gaussian integration (Gaussian – Legendre Formula 2 point and 3 point)

6. Solution of ordinary differential equations (6 hours)

6.1. Euler's and modified Euler's method
6.2. RungeKutta methods for 1st and 2nd order ordinary differential equations

6.3. Solution of boundary value problem by finite difference method and shooting method.

7. Numerical solution of Partial differential Equation (8 hours)

7.1. Classification of partial differential equation (Elliptic, parabolic, and Hyperbolic)
7.2. Solution of Laplace equation (standard five point formula with iterative method)
7.3. Solution of Poisson equation (finite difference approximation)
7.4. Solution of Elliptic equation by Relaxation Method
7.5. Solution of one dimensional Heat equation by Schmidt method

Practical:

Algorithm and program development in C programming language of following:

1. Generate difference table.
2. At least two from Bisection method, Newton Raphson method, Secant method
3. At least one from Gauss elimination method or Gauss Jordan method. Finding largest Eigen value and corresponding vector by Power method.
4. Lagrange interpolation. Curve fitting by Least square method.
5. Differentiation by Newton's finite difference method. Integration using Simpson's 3/8 rule
6. Solution of 1st order differential equation using RK-4 method
7. Partial differential equation (Laplace equation)
8. Numerical solutions using Matlab.

References:

1. Dr. B.S. Grewal, "Numerical Methods in Engineering and Science ", Khanna Publication.
2. Robert J schilling, Sandra l harries , " Applied Numerical Methods for Engineers using MATLAB and C.", Thomson Brooks/cole.
3. Richard L. Burden, J. Douglas Faires, "Numerical Analysis", Thomson / Brooks/cole
4. John. H. Mathews, Kurtis Fink ,"Numerical Methods Using MATLAB" ,Prentice Hall publication
5. JAAN KIUSALAAS , "Numerical Methods in Engineering with MATLAB", Cambridge Publication

Evaluation scheme:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below

Unit	Chapter	Topics	Marks
1	1 & 2	All	16
2	3	All	16
3	4	All	16
4	5	All	16
	6	6.1 & 6.2	
5	6	6.3	16
	7	All	
Total			80

THEORY OF VIBRATION
AE

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objective:

To provide basic concept for the dynamics response analysis of common machines and machine components. To model a given system for a vibratory response. To develop computer simulation and program for the dynamic response

1. Engine Force Analysis **(2hours)**

1.1. Analytical Method for Velocity and Acceleration of the Piston and the Connecting Rod
1.2. Equivalent Dynamical System
1.3. Analytical Method for Inertia Torque
1.4. Graphical Method for Velocity and Acceleration of the Piston and the Connecting Rod

2. Turning Moment Diagram and Flywheel **(2hours)**

2.1. Turning Moment Diagram
2.2. Fluctuation of Energy and Coefficient of Fluctuation of Energy
2.3. Flywheel
2.4. Coefficient of Fluctuation of Speed
2.5. Energy Stored in a Flywheel and Flywheel Sizing

3. Gyroscopic Couple **(3 hours)**

3.1. Precessional Angular Motion
3.2. Gyroscopic Couple
3.3. Effect of Gyroscopic Couple on Aeroplane
3.4. Stability of a Four Wheel and Two Wheel Vehicles
3.5. Effect of Gyroscopic Couple on a Disc Fixed Rigidly at a Certain Angle to a Rotating Shaft

4. Governors **(4 hours)**

4.1. Function of a Governer
4.2. Terms Used in Governer
4.3. Types of Governers
4.4. Sensitiveness and Stability of Governors

5. Balance of Machinery **(6 hours)**

5.1. Balancing of a Single Rotating Mass by a Single Mass Rotating in the Same Plane
5.2. Balancing of a Single Rotating Mass by Two Masses Rotating in Different Planes
5.3. Balancing of Several Masses Rotating in the Same Plane
5.4. Balancing of Several Masses Rotating in the Different Planes
5.5. Types of Balancing Machines
5.6. Balancing of Reciprocating Masses
5.7. Balancing of Multicylinder Engines, In-line, V-type, Opposed and Radial Configurations
5.8. Balance of Four Bar Linkages

6. Vibration of Single Degree of Freedom Systems **(10 hours)**

6.1. Definition and Effects of Vibration, Terms Used in Vibration

6.2. Elements of a Vibrating System
6.3. Undamped Vibration of Single Degree of Freedom System
6.4. Damped Vibration of Single Degree of Freedom System
6.5. Forced Harmonic Response of Single Degree of Freedom System with Viscous Damping
6.6. Systems with Coulomb Damping
6.7. Rotating Unbalance
6.8. Whirling of Rotor-Shaft Systems
6.9. Vibration Isolation and Force Transmissibility
6.10. Response of Harmonic Excitation of Support
6.11. Vibration Measuring Instruments
6.12. Energy Dissipated by Damping
6.13. Convolution Integral and General Force Excitation

7. Vibration of Two Degree of Freedom Systems (4hours)

7.1. Undamped Vibration of Two Degrees of Freedom System, Natural Frequencies and Mode Shapes
7.2. Damped Vibration of Two Degrees of Freedom System
7.3. Forced Harmonic Vibration of Two Degrees of Freedom System
7.4. Vibration Absorber

8. Vibration of Multi Degree of Freedom Systems (6 hours)

8.1. Equations of Motion in Matrix Form
8.2. Flexibility and Stiffness Matrices, Reciprocity Theorem
8.3. Eigenvalues and Eigenvectors, Orthogonal Properties of Eigenvectors
8.4. Modal Analysis
8.5. General Forced Response

9. Approximate Numerical Methods (4 hours)

9.1. Rayleigh Method
9.2. Rayleigh-Ritz Method
9.3. Dunkerley Method
9.4. Matrix Iteration Methods
9.5. Finite Difference Method

10. Vibration of Continuous Systems (4 hours)

10.1. Lateral Vibration of a String
10.2. Longitudinal Vibration in Rods
10.3. Torsional Oscillation in Circular Shafts
10.4. Lateral Vibration in Beams

Practical:

1. Response of Governors
2. Experiment on Gyroscope
3. Balancing of Rotating Masses
4. Response of a Spring Mass System
5. Whirling of a Rotating Shaft

References:

1. H. Mabie and C.F. Reinholtz, “Mechanisms and Dynamics of Machinery”, H, Wiely.
2. W. T. Thomson, “Theory of Vibration with Applications”, Prentice Hall.

3. S.S. Rao, "Mechanical Vibrations", Addison Wesley.
4. S. G. Kelly, "Fundamentals of Mechanical Vibrations", McGraw Hill.
5. A. Gilat, "MATLAB An Introduction with Applications", Wiley India.

Evaluation Scheme:
There will be questions covering all the chapters of the syllabus. The evaluation scheme will be indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 3	All	16
2	4 & 5	All	16
3	6	All	16
4	7 & 8	All	16
5	9 & 10	All	16
Total			80

CONTINUUM MECHANICS
AE

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objective:

The main objective of this course is to provide fundamental knowledge and skills to solid mechanics. After completion of this course the students will be able to know in depth knowledge of general stress and strain.

COURSE OUTLINE:

1. Load on Structure and Response of Material **(1 hour)**

1.1. General Load on Structure and its Effects
1.2. Elastic and Non-elastic Response of Solids
1.3. Isotropy, Anisotropy, Continuity and Homogeneity
1.4. Effect of temperature on Elastic and Plastic range of Solids

2. Stress Tensor **(6 hours)**

2.1. Definition
2.2. Stress at a point
2.3. Stresses on Structure due to General Load
2.4. Stress Notation and Sign Convention
2.5. Stresses Acting on Arbitrary Planes
2.6. Transformation of Stress and Principal Stress
2.7. Stress on Deformable Body
  2.7.1. Differential Equation in Rectangular Co-ordinate System
  2.7.2. Differential Equation in Polar Co-ordinate System
  2.7.3. Application of Differential Equation and Its Solution
2.8. Relevant Problems

3. Deformable Body and Strain Tensor **(4 hours)**

3.1. Definition
3.2. Strain at a point
3.3. Strain on Structure due to General Load
3.4. Strain Notation and Sign Convention
3.5. Strain Acting on Arbitrary Planes
3.6. Transformation of Strain and Principal Strain
3.7. Small Displacement Theory
3.8. Volumetric Strain
3.9. Relevant Problems

4. General Hooke's Law **(2 hours)**

4.1. Definition
4.2. Internal Energy Density
  4.2.1. Strain Energy
  4.2.2. Complementary Strain Energy

- 4.3. Anisotropic and Isotropic Elasticity
- 4.4. Equations of Thermo-elasticity for Isotropic Materials

5. Deflections and Slope of Statically Determinate and Indeterminate Structures(6 hours)

- 5.1. Definition
- 5.2. Application in Engineering Field
- 5.3. Energy Method
- 5.4. Unit Force Method
- 5.5. Castigliano's Theorem
- 5.6. Relevant Problems

6. Curved Beams (4 hours)

- 6.1. Definition
- 6.2. Circumferential Stress in Curved Beams
- 6.3. Radial Stresses
- 6.4. Deflections
- 6.5. Statically Indeterminate Closed Ring
- 6.6. Relevant Problems

7. Bending of Thin Plates (6 hours)

- 7.1. Pure Bending of Thin Plates
- 7.2. Plates subjected to bending and Twisting
- 7.3. Plates subjected to a distributed transverse load
- 7.4. Combined bending and in-plane loading of a thin rectangular plate
- 7.5. Bending of thin plates having small initial curvature
- 7.6. Energy method for the bending of thin plates
- 7.7. Relevant Problems

8. Torsion (6 hours)

- 8.1. Definition
- 8.2. Torsion of Non Circular Solid Section
  - 8.2.1. Saint- Venant's Semi- Inverse Method
  - 8.2.2. The Prandtl Elastic Membrane Analogy
  - 8.2.3. Torsion of a Narrow Rectangular Cross Section
- 8.3. Torsion of Hollow Thin Wall Section
- 8.4. Relevant Problems

9. Shear Centers for Thin- Wall Beam Cross Sections (4 hours)

- 9.1. Shear Flow in thin- Wall Beam Cross Sections
- 9.2. Shear Centre for a Channel Section
- 9.3. Composite Beams
- 9.4. Box Beams
- 9.5. Relevant Problems

10. Structural Instability of Thin Plates (6 hours)

- 10.1. Buckling of thin Plates

10.2. Inelastic buckling of plates
10.3. Local Instability
10.4. Instability of Stiffened Panels
10.5 Failure stresses in Plates and Stiffened Panels
10.6 Tension Field Beams
10.7 Relevant Problems

REFERENCES

1. T. H. G Megson "Aircraft Structures for Engineering Students"
2. A.p. Boresi and O. M. Sidebottom, *'Advanced Mechanics of Materials'*, Wiley, Fourth Edition 15
3. Ugural and Fenster, *'Advanced Strength and Applied Elasticity'*, Elsevier, Second Edition, S. I. Version
4. Popov, E.P., 'Engineering Mechanics of Solids
5. Hibbler R.C., Mechanics of Solids

LABORATORIES

1. Nonlinear Behaviour of Materials in Tension
   i. Tensile Test on a Rubber Specimen
   ii. Creep Test and relaxation Test on a Plastic Specimen
2. Deflections and Stresses in Indeterminate Shafts of Beams:
   i. Control of stresses and deflections using a central support
   ii. Application of Maxwell's reciprocity law
3. Torsion of Non Circular tubes:
   i. Torsion test of circular, square and rectangular closed thin walled tubes
   ii. Torsion of closed and open circular thin- walled tubes
4. Curved Beams and Thick- Walled Cylinders
   i. Deflections and Stresses in curved beams
   ii. Stress and strain in thick walled cylinders
5. Shear stresses in beams and the shear centre:
   i. Shear stresses in beams and stiffness effects for layered beams
   ii. Finding the shear centre for a beam with a channel cross section
6. Effects of Suddenly Applied Dynamic Loads:
   i. A tension member subjected to dynamic loads
   ii. Sudden transverse loading of a beam

EVALUATION SCHEME:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the tablebelow.

Evaluation Scheme:
The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 4	All	16
2	3 & 5	All	16
3	6 & 8	All	16
4	7 & 9	All	16
5	10	All	16
Total			80

AIRCRAFT PROPULSION
AE

Lecture : 4 **Year : III**
Tutorial: 0 **Part : I**
Practical : 3/2

Course Objective:

The main objective of this course is to provide fundamental knowledge and skills to Aircraft Propulsion. After completion of this course the students will be able to know in depth knowledge of design process of Propulsion systems.

1. Introduction **(4 hours)**

- 1.1 Brayton Cycle
- 1.2 Types of Jet Engine
- 1.3 Components of Jet Engine
- 1.4 Basics of Total and Static Enthalpies
- 1.5 Thrust Equations and Propulsive Efficiencies

2. Fundamentals of Thermal Turbo-machines **(8 hours)**

- 2.1 Review on Compressible Aerodynamics
- 2.2 Turbo-machine System Discretization
- 2.3 Fundamental Equations
  - 2.3.1 Conservation of Mass
  - 2.3.2 Conservation of Energy
  - 2.3.3 Conservation of Momentum
  - 2.3.4 Euler's Turbine Equation
  - 2.3.5 Rothalpy
- 2.4 Efficiencies
  - 2.4.1 Isentropic Efficiency
  - 2.4.2 Calculating with Isentropic Efficiencies
  - 2.4.3 Polytropic Efficiency

3. Combustion Chambers and Nozzles **(8 hours)**

- 3.1 Classification of combustion chambers
- 3.2 Important factors affecting combustion chamber design
- 3.3 Combustion process
- 3.4 Combustion chamber performance
- 3.5 Effect of operating variables on performance
  - 3.5.1 Flame tube cooling
  - 3.5.2 Flame stabilization
  - 3.5.3 Use of flame holders
- 3.6 Theory of flow in isentropic nozzles
- 3.7 Convergent nozzles and nozzle choking
- 3.8 Nozzle throat conditions
  - 3.8.1 Nozzle efficiency
  - 3.8.2 Losses in nozzles
  - 3.8.3 Over expanded and under Expanded nozzles
  - 3.8.4 Ejector and variable area nozzles

3.8.5 Interaction of nozzle flow with adjacent surfaces

4. Compressors **(14 hours)**

4.1 Types of Compressors
4.2 Stage Velocity Triangle
4.3 First Design Parameter: Degree of Reaction
4.4 Second Design Parameter: Loading Factor
4.5 Third Design Parameter: Flow Coefficient
4.6 The Normalized Velocity Triangle
4.7 Special Cases
4.7.1 Degree of Reaction equal to one half ($R = 0.5$)
4.7.2 Zero Exit Swirl ($C\theta,3 = 0$)
4.8 Simplified Off-Design Analysis
4.9 Axial Compressor - Effect of Degree of Reaction
4.10 Compressor Design Aspects
4.10.1 Axial Compressor Rotor Types
4.10.2 Multiple Rotors
4.10.3 Rotor Blade Mount
4.10.4 Stator Vane Mount
4.10.5 Variable Stage Geometry
4.11 Surge Control (Bleed Valve)
4.12 Boundary Layer Control
4.13 Aspiration
4.14 Blade Twist

5. Turbines **(12 hours)**

5.1 Types of Turbine
5.2 Stage Velocity Triangles
5.3 First Design Parameter: Degree of Reaction
5.4 Second Design Parameters: Loading Factor
5.5 Third Design Parameters: Flow Coefficient
5.6 The Normalized Velocity Triangle
5.7 Special Cases
5.7.1 Degree of Reaction Equal to Zero ($R = 0$; Action Turbine)
5.7.2 Degree of Reaction equal to one half ($R = 0.5$; Reaction Turbine)
5.7.3 Zero Exit Swirl ($C\theta,3 = 0$)
5.8 Axial Turbine - Effects of Degree of Reaction
5.9 Turbine Design Aspects
5.9.1 Disk Rotor
5.9.2 Drum Rotor
5.9.3 Sealing Aspects
5.9.4 Action Turbine
5.9.5 Reaction Turbine
5.9.6 Turbine Blade Geometry
5.9.7 Three-Dimensional Effects

5.10 Design of Multistage Turbine
5.11 System Discretization
5.12 Problem Statement
5.12.1 Determination of Approximate Flow Parameters
5.12.2 Determination of Inlet and Outlet Angular Geometry
5.12.3 Determination of Number of Stages
5.12.4 Determination of Stage Efficiency
5.12.5 First Iteration of Flow Parameters
5.12.6 Finalization of First Iteration

6. Losses in Turbo-machines **(4 hours)**

6.1 Losses
6.2 Losses in a Turbine Stage
6.3 Loss Coefficients
6.4 Dependency of the Efficiency from Design Parameters
6.5 Reaction Turbine (R = 0.5)
6.6 Action Turbine (R = 0)

7. Propulsion **(10 hours)**

7.1 Turbine Engines
7.1.1 Construction Arrangement and operation of turbojet, turbofan, turbo-shaft and turbo-propeller engines.
7.1.2 Electronic Engine Control and Fuel Metering Systems (FADEC)
7.2 Engine Indicating Systems (EICAS/ECAM)
7.2.1 EGT/ITT
7.2.2 Engine Speed
7.2.3 Engine Thrust Indication
7.2.4 Oil Pressure and Temperature
7.2.5 Fuel Pressure, Temperature and Flow
7.2.6 Manifold Pressure, Engine Torque and Propeller Speed
7.3 Starting and Ignition System
7.3.1 Operation of Engine Start Systems and Components
7.3.2 Ignition Systems and Components
7.3.3 Maintenance Safety Requirements

References

1. Dixon, S.L., 1998 "Fluid Mechanics and Thermodynamics of Turbomachinery" 4th Edn. Butterworth-Heinemann, Woburn, MA, USA, 1998 (ISBN 0-7506-7059-2)
2. Soderberg, C.R., 1949 Unpublished Note, Gas Turbine Laboratory, Massachusetts Institute of Technology
3. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Addison – Wesley Longman INC, 1999.
4. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. “Gas Turbine Theory”, Longman, 1989.
5. Oates, G.C., “Aero thermodynamics of Aircraft Engine Components”, AIAA Education Series, New York, 1985.

6. “Rolls Royce Jet Engine” – Third Edition – 1983.
7. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers &Distributors, Delhi, 1999.
8. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 5th Edn., 1993.
9. http://web.mit.edu/16.unified/www/SPRING/propulsion/notes/node70.html
10. FAA Aircraft Propulsion 12A and 15A

Project

1. Simulation of Axial Compressor or Turbine in available CFD Software.

Details of Project:

Euler's Radius	= ____________	
Pressure Ratio of a stage	= ____________	
Mass Flow Rate (kg/s)	= ____________	(Through a sector)
Thermal Head (J)	= ____________	(Total quantity)
Density of gas (kg/m3)	= ____________	(average value in that sector)
Stage Inlet Temperature (K)	= ____________	
Stage Pressure at Inlet	= ____________	
Tip Clearance	= ____________	(% of blade span)

Hint:

1. Use Euler's Turbine Equation to find the LE and TE stagger angle.
2. Approximate a curve tangential to these curves found in step 1.
3. Use appropriate airfoil/thickness ratio for 2D design.
4. Develop 3D design from data and above steps.
5. Carry out CFD simulation for the given conditions

Note: Assume appropriate data if missing.

Evaluation Scheme:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1 & 3	All	16
2	4	All	16
3	5	All	16
4	2 & 6	All	16
5	7	All	16
Total			80

FAULT MONITORING AND DIAGNOSIS
AE

Lecture : 3 | **Year : III**
Tutorial : 1 | **Part : I**
Practical : 3/2

Course Objectives:
To establish the complete system and frame work, and comprehensively introduce the common detection and diagnosis techniques.

1. Introduction (2 Hours)

1.1 The Significance of Aircraft Detection and Diagnosis Technology
1.2 Development of Aircraft Maintenance Theory
1.3 Condition Monitoring and Fault Diagnosis Technique for Aero Engine
1.4 Inspection and Repair Techniques for Aircraft Structure
1.5 Introduction to Maintenance Steering Group (MSG)

2. Fault Signal Analysis and Processing (12 Hours)

2.1 The concept and classification of Signal
2.2 Time domain analysis
2.3 Frequency domain analysis
2.4 Digital Signal Analysis and Processing
2.5 Digital Image Analysis and Processing

3. Theories of Fault Recognition (8 Hours)

3.1 Bayseian Classification
3.2 Classification based in distance functions
3.3 Fuzzy Diagnosis
3.4 Grey Diagnosis
3.5 Neural Network Diagnosis
3.6 Support Vector Machine Diagnosis
3.7 Time Series Forecasting Method
3.8 Expert System Diagnosis

4. Aero-engine state diagnosis (6 hours)

4.1 Basic principle of engine state diagnosis
4.2 Basic Concepts of Fault Diagnosis
4.3 Fault Equations
4.4 Mathematics Foundation for Solving fault equations
4.5 Fault Equation Solution
4.6 Application Example

5. Aero-Engine Condition Monitoring and Fault Diagnosis based on Vibration(12 Hours)

5.1 The vibration monitoring and diagnosis for aero-engine
5.2 The main exciting sources of aero-engine
5.3 The common faults mechanism analysis of rotor system

5.4 Common Faults and their diagnosis of gear
5.5 The common faults and their diagnosis of ball bearing
5.6 Fault diagnosis cases of aero engine.

6. Aero-engine wear condition monitoring and fault diagnosis (5 Hours)

6.1 Introduction
6.2 The classification and application range of oil analysis methods
6.3 Magnetic Plug detecting method
6.4 Oil Spectral Analysis
6.5 Oil Ferrography Analysis
6.6 Oil Analysis Diagnosis Cases

7. Aero- Engine Trend Analysis (1 Hours)

7.1 Aero- Engine Trend Graph analysis technique
7.2 Aero-engine performance trend forecasting

8. Fingerprint Graph analysis method of Aero engine (2 Hours)

8.1 Introduction
8.2 Fingerprint Graph
8.3 Fingerprint Graph Analysis
8.4 Fault Diagnosis Example

9. Aero- engine Borescope Detection Technology (4 Hours)

9.1 Endoscopy and its development process.
9.2 The application of boroscope in the engine damage detection
9.3 New Boroscope equipment and its principle
9.4 The development tendency of Borescope
9.5 Aero-engine interior damage remote evaluating expert system.

10. Non Destructive Testing (NDT) Technique for Aircraft Structural Inspection(6 Hours)

10.1 The significance and Function of NDT in Aviation Maintenance
10.2 Ultrasonic Testing
10.3 EC Testing Methods
10.4 MP Testing Methods
10.5 X-Ray Method
10.6 FP Testing

11. Civil Aircraft Leakage Detection Techniques (2 Hours)

11.1 The significance of Aircraft leakage detection
11.2 The methods of Aircraft Leakage Detection
11.3 The leakage detection of aircraft structure fuel tank.

References:

1) Mechanical Fault Diagnosis and Condition Monitoring by R.A Collaccot, Chappman and Hall, London, ISBN 978-94-009-5723-7
2) Aircraft Detection and Diagnosis Techniques, by Chen Guo, NUAA, China

3) Gas Turbine Diagnostics: Signal Processing and Fault Isolation, R Ganugly, CRC Press

Practical
Industry visit to various Aircraft Maintenance Organization and observe the various techniques they use for aircraft fault detection and prepare a report with better recommendations.

Evaluation Scheme:
The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 7, 8 & 11	All	16
2	2	All	16
3	3 & 4	All	16
4	5	All	16
5	6, 9 & 10	All	16
		Total	80

AIRCRAFT MANUFACTURING PROCESS
AE

Lecture : 3 **Year : III**
Tutorial : 0 **Part : I**
Practical : 2

Course Objectives

Make clear the necessary parts, optional parts, distribution of hours. Courses with experiments or practice are expected to explain hours needed, content, scheme and functions.

1. Overview of Aircraft Manufacturing **(2 hours)**

1.1 Introduction
1.2 Product Cycle
1.3 Material Flow and Processing
1.4 Information Flow
1.5Evolution of Organization for Manufacture

2. Manufacturing Properties of Materials **(3 hours)**

2.1 Mechanical Properties of Solids
2.2 Deformation of Solids
2.3 Thermo Fluid Properties of Liquids
2.4 Tribology in Manufacturing

3. Properties of Manufactured Products **(3 hours)**

3.1 Geometrical Description and Tolerances
3.2 Dimensioning and Tolerances Control
3.3 Surface Configurations
3.4 Residual Stresses

4. Bulk Deformation Process **(6 hours)**

4.1 General Characteristics of Bulk Deformation Process and Products
4.2 Force, Energy and Deformation: Sensitivity to frictions, geometry, temperature and deformation rate
4.3 Forging practice and Technology; Press and hammers, tooling design, manufacture wear
4.4 Design of Forgings; Characteristics and defects in forgings
4.5 Flat Rolling; Characteristics and defect in forgings
4.6 Shape Rolling: Process and Products
4.7 Extrusion
4.8. Wires, Bar and Tube Drawing

5. Sheet Metal Product Manufacturing Process **(4 hours)**

5.1 Shearing and Punching Operations
5.2 Sheet Metal and Tube Bending: Technology and Practices
5.3 Deep Drawing and Hydro forming
5.4 Spinning Operations and Capabilities
5.5 Formability Assessment

6. Material Removal Processes: “Chip-forming” **(6 hours)**

6.1 Modeling the cutting process
6.2 Force, Power and Productivity Relationship
6.3 Cutting tools Materials: Characteristics and Economics
6.4 General Purpose Machine Tool Types

- 6.1.1 Operation of Lathes, Milling, Shapers and Drilling Machines
- 6.1.2 Application of Shaping, Planning and Slotting Machines

6.5 Methods of mounting of jobs and cutting tools in machine tools
6.6 Uses of various attachments in machine tools
6.7 Control of Machine Tools and Product Properties
6.8 Cutting off Process: Saws, flame cutting, arc cutting

7. Manufacturing of Polymeric Matrix Composites (6 hours)

7.1 Relate the fundamental physics in composite manufacturing.
7.2 Identify the available manufacturing processes for polymeric composites.
7.3 Describe typical defects introduced in manufacturing and the methods utilized to minimize these defects.
7.4 Define common terminology in composites manufacturing.
7.5 Recognize special tooling considerations required for composite manufacturing.

8. Manufacturing Technologies & Aircraft Structural Parts (7 hours)

8.1 Preface
8.2 Technology Properties of Aircraft Integral Structures
8.3 Manufacture of Aircraft Integral Panels

- 8.3.1 Blank Supply
- 8.3.2 Machining
- 8.3.3 Chemical Milling of Integral Panels
- 8.3.4 Forming of Integral Panels
- 8.3.5 Manufacturing of Integral Forms, Ribs and Spars
- 8.3.6 Manufacturing of Large-Sized Skeleton

9. Assembly theory and methods (8 hours)

9.1 Structure Assembly
9.2 Framing
9.3 Shimming
9.4 Hole Drilling
9.5 Fasteners
9.6 Sealing
9.7 Painting
9.8 Tooling design for aircraft assembly

Practical:

1. Write a synopsis of recent 5 journal papers published in last five years.
2. Design a manufacturing process of an aircraft component (e.g. Turbine Blade, Landing Gear struts). Prepare a report.
3. Fabricate Composite Panel at Lab and prepare report.

Remarks:

1. Pradip K. Saha, Aerospace Manufacturing Process, CRC Press, 2016
2. Sam Zhang, Donglian Zhao, Aerospace Materials Handbook, CRC Press
3. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Process and Systems

Evaluation Scheme:
The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1, 2, 3& 5	All	16
2	4 & 6	All	16
3	7	All	16
4	8	All	16
5	9	All	16
		Total	80

Syllabus

Year - III, Part - II

Bachelors of **Aerospace Engineering**

Department of Mechanical Engineering

Institute of Engineering

Pulchowk Campus

Tribhuvan University

Date: 31/02/2075

AVIONICS
AE

Lecture : 3 **Year : III**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:
The course should enable the students to understand the needs of avionics for both Civil and Military aircraft, introduce various digital electronic principles and working operations of digital circuit, integrate the digital electronics with cockpit equipment, understand the various principles in flight desk and cockpit panels and study the communication and navigation equipment.

1. Introduction to Avionics **(8 Hours)**
- 1.1 Need for Avionics
- 1.2 Components Overview
- 1.3 Systems that Interact with the Pilot
- 1.4 Fly-By-Wire, Flight Management and Autopilot Systems
- 1.5 Sensors Systems
- 1.6 Task Automation Systems
- 1.7 Overview of Aircraft Stability and Control

2. Cockpit Displays and Human-Machine Interface **(8 Hours)**
- 2.1 Functions of the Cockpit Systems
- 2.2 Primary Flight Display
- 2.3 Analog Display Systems in the Cockpit
- 2.4 Flight Control Instruments (Side-Stick, Yoke, Throttle, Pedal, etc.)
- 2.5 Analog Controls
- 2.6 Fly-By-Wire System

3. Basic Navigation Systems **(4 hours)**
- 3.1 Principle of Navigation System
- 3.2 Types of Navigation Systems- Position Fixing and Dead-Reckon

4. Fly-By-Wire System, Autopilot and Flight Management **(4 Hours)**
- 4.1 Fly-By-System Architecture and Data Handling
- 4.2 Failure Safety and Triplex/Quadruplex Redundancies
- 4.3 Flight Management and Housekeeping
- 4.4 Data Fusion

5. Communication and NavigationSystems-I **(16 Hours)**
- 5.1 Fundamentals of
  - 5.1.1 Radio Wave Propagation
  - 5.1.2 Antennas and transmission lines
  - 5.1.3 Communication
  - 5.1.4 Receiver and transmitter
- 5.2 Working principle of following systems
  - 5.2.1 VHF Communication
  - 5.2.2 HF Communication
  - 5.2.3 Audio Systems
  - 5.2.4 ELT (Emergency Locator Transmitter)

5.2.5 CVR (Cockpit Voice Recorder)
5.2.6 VOR (Very High Frequency Omnidirectional Range)
5.2.7 ADF (Automatic Direction Finding)
5.2.8 ILS (Instrument Landing System)
5.2.9 DME (Distance Measuring Equipment)

6. Communication and Navigation System-II **(8 Hours)**

6.1 Working principle of following systems
6.1.1 VLF/ Omega (Very low frequency and hyperbolic navigation)
6.1.2 Doppler Navigation
6.1.3 Area Navigation , RNAV System
6.1.4 FMS (Flight Management System)
6.1.5 GPS (Global Positioning System)
6.1.6 GNSS Satellite System
6.1.7 Inertial Navigation System
6.1.8 ATC Transponder, Secondary Surveillance Radar
6.1.9 TCAS (Traffic Alert and Collisions Avoidance System)
6.1.10 Weather Avoidance Radar
6.1.11 Radio Altimeter
6.1.12 ARINC Communication and Reporting

Laboratory/ Project Works:

Practical means project work and report have to be submitted at the end of the course. The report should be around 20-30 pages plus appendix.

- Case study
- Site visit

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the questions will be indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	All	16
2	2	All	16
3	3 & 4	All	16
4	5	All	16
5	6	All	16
Total			80

AIRCRAFT ENVIRONMENT CONTROL SYSTEM
AE

Lecture : 3 **Year : III**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:
The aircraft environmental control is vital to modern aircraft because of increasingly comfort level for commercial airliners and intensively avionics cooling for military aircraft. This course mainly focuses on fundamentals of aircraft environmental control and aircraft control systems and components. Fundamentals of aircraft environmental control mainly include atmosphere, aviation physiology, phycrometrics and air conditioning processes.

1. Atmosphere and Aviation Physiology (6 hours)

1.1 Structures of atmosphere
1.2 Composition of atmosphere
1.3 Dalton's law and ideal gas law
1.4 Standard atmosphere
1.5 Environmental design conditions
1.6 Anoxia
1.7 Decompression disorders
1.8 Effect performance times

2. Phycrometrics and Air Conditioning Processes (8 hours)

2.1 Properties of moist air (Partial pressure, saturation pressure, moist content, dry-bulb temperature, wet-bulb temperature, dew-point temperature, relative humidity)
2.2 American phycrometrics
2.3 Molliar diagram
2.4 Heating processes
2.5 Dry cooling and wet cooling processes
2.6 Adiabatic humidification processes
2.7 Dehumidification processes
2.8 Adiabatic mixing processes

3. Air Cycle Refrigeration Systems and Design (16 hours)

3.1 Scopes
3.2 Heat sinks
3.3 Carnot cycles
3.4 Simple air cycle refrigeration systems (ACRS)
3.5 Bootstrap ACRS
3.6 Three wheel ACRS
3.7 High pressure water separation ACRS
3.8 Regeneration ACRS
3.9 Closed loop ACRS
3.10 Reverse bootstrap ACRS

4. Vapor Cycle Refrigeration Systems and Design (10 hours)

4.1 Refrigerants
4.2 p-h diagrams
4.3 Ideal vapor cycle refrigeration systems (VCRS)
4.4 Factors affecting VCRS performances
4.5 Two stage VCRS
4.6 Cascade VCRS
4.7 Other variations of VCRS
4.8 Combinations of ACRS and VCRS

5. Refrigeration Components (12hours)

5.1 Heat exchangers (principles; structures, effectiveness, design methods)
5.2 Turbines (principles; structures, efficiency performances, mass flow performances, design methods)
5.3 Compressors (principles; structures, efficiency performances, mass flow performances, design methods)
5.4 Fans (principles; structures, efficiency performances, similarities, design methods)
5.5 Air ducts
5.6 Air scoops.

Practical:

1. Lab: Atmosphere and Aviation Physiology, including relationships of altitude and pressure, relationships of water saturation pressure and temperature, reactions of animals to pressure changes
2 Lab: Simple air cycle environmental control system; Project: An ACRS design.
3. Project: Heat exchanger design

References:

1. Bill Neese "Aircraft Environmental Systems" Endeavor Books, 1999
2. Alvin, "Fundamentals of Aircraft Environmental Control" Hayden Book Co., 1968
3. Ian Moir, Allan Seabridge, "Environmental Control Systems", John Wiley & Sons, Ltd, 2008
4. M. Dechow, C.A.H. Nurcombe, "Aircraft Environmental Control Systems", The Handbook of Environmental Chemistry book series (HEC, volume 4H)

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the questions will be indicated in the table below:

Unit	Chapter	Topics	Marks
1	1& 3 (3.8 – 3.10)	All	16
2	2	All	16
3	3 (3.1 – 3.7)	All	16
4	4	All	16
5	5	All	16
Total			80

FLIGHT DYNAMICS
AE

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objective:

The course introduces students to the performance, stability, and control of a wide range of airborne vehicles. Attention is given to mathematical models and techniques for analysis, simulation, and evaluation of flying qualities, with brief discussion of guidance, navigation, and control issues. Topics include equations of motion, configuration aerodynamics, analysis of linear systems, and longitudinal/lateral/directional motions.

Course Outline:

1. Introduction **(6 Hours)**

1.1. Introduction, Mathematical Preliminaries
  1.1.1.Introduction to Flight Dynamics
  1.1.2.Flight of a Paper Airplane
  1.1.3. Math Preliminaries
1.2. Point-Mass Dynamics and Aerodynamic Forces
  1.2.1. The Atmosphere
  1.2.2. Equation of motion for a particle (Point Mass)
  1.2.3. Introduction to lift and drag
  1.2.4. Equations of motion with Aerodynamics and Thrust
  1.2.5. Introduction to Aerodynamic Propulsion

2. Configuration Aerodynamics **(10 Hours)**

2.1. Low-Speed Aerodynamics
  2.1.1. 2D Aerodynamic Lift and Drag
    Effect of sweep angle on lift
    Thin Aerofoil theory
  2.1.2. Description of Aircraft configuration
  2.1.3. 3D Aerodynamic Lift and Drag
    Wing twist effects
    Aerodynamic Strip Theory
    Effect of aspect ratio on 3D wing lift slope coefficient
    Longitudinal Control Surfaces
2.2. Induced Drag and High-Speed Aerodynamics
  2.2.1. Induced Drag
  2.2.2. Mach Number Effects
  2.2.3. Newtonian flow and High-Angle-of-Attack Lift and Drag
2.3. Aerodynamic Moments
  2.3.1. Spanwise Lift Distribution of 3D Wings
  2.3.2. Secondary wing Structures
    Wingtip Design
    Sweep Effect on Thickness Ratio
  2.3.3. Moments of the airplane

- 2.3.4. Airplane Balance
- 2.3.5. Pitching Moment of the Airplane
- 2.3.6. Lateral-Directional Effects of Sideslip Angle
- 2.3.7. Tail Design Effects
- 2.3.8. Propeller Effects

3. Flight Performance **(8 hours)**

- 3.1. Cruising Flight Performance
  - 3.1.1. Flight in Vertical Plane
  - 3.1.2. Steady, Level Flight
  - 3.1.3. The Flight Envelop
  - 3.1.4. Optimal Crusing Flight
- 3.2. Gliding, Climbing, and Turning Flight Performance
  - 3.2.1. Gliding Flight
  - 3.2.2. Climbing Flight
  - 3.2.3. Optimal Climbing Flight
  - 3.2.4. The Maneuvering Envelope
  - 3.2.5. Turning Flight

4. Equations of Motion **(12 hours)**

- 4.1. Aircraft Equations of Motion - Translation and Rotation
  - 4.1.1. Translational Position
  - 4.1.2. Rotational Orientation
  - 4.1.3. Angular Momentum
  - 4.1.4. The Inertia Matrix
  - 4.1.5. Rate of Change of Angular Momentum
- 4.2. Aircraft Equations of Motion - Flight Path Computation
  - 4.2.1. Euler Angle Rates
  - 4.2.2. Rigid-Body Equation of Motion
  - 4.2.3. FLIGHT-Computer Program to Solve the 6-DOF Equation of Motion
  - 4.2.4. Examples from FLIGHT
  - 4.2.5. Aerodynamic Damping
- 4.3. Aircraft Control Devices and Systems
  - 4.3.1. Control Surface Types
  - 4.3.2. Control Surface Aerodynamics
  - 4.3.3. Control Mechanization Effects
  - 4.3.4. Yaw Damping
  - 4.3.5. Flight Control Systems

5. Linearized Motion in Flight **(12 hours)**

- 5.1. Linearized Equations of Motion
  - 5.1.1. Linear, Time-Varying(LTV) Approximation of Perturbation Dynamics
  - 5.1.2. Separation of Equation of Motion into Longitudinal and Lateral Directional Sets
  - 5.1.3. Decoupling Approximation for Small Perturbations from Steady, Level Flight
- 5.2. Linearized Longitudinal Equations of Motion

5.2.1. Fourth-Order Hybrid Equations of Motion
5.2.2. Dimensional Stability and Control Derivatives
5.2.3. Comparison of 2nd and 4th order Model Response
5.3. Linearized Lateral-Directional Equations of Motion
5.3.1. Linearized Lateral-Directional Equation of Motion in Steady, Level Flight
5.3.2. Stability Axis Representation of Dynamics
5.3.3. 2nd Order Approximate Modes of Lateral-Directional Motion
5.3.4. Comparison of 4th and 2nd Order Dynamic Models

6. Methods of Analysis and Design (12 hours)
6.1. Maneuvering at High Angles and Angular Rates
6.1.1. Coupling of Longitudinal and Lateral-Directional Motions
6.1.2.Tumbling and Spins
6.1.3.Control at Height Aerodynamic Angles
6.2. Aeroelasticity and Fuel Slosh
6.2.1. One-Dimensional Mode of Aeroelasticity
6.2.2. Fuel Shift and Slosh
6.3. Problems of High Speed and Altitude
6.3.1. Effects of Air Compressibility on Flight Stability
6.3.2. Altitude/Airspeed Instability
6.3.3. Variable-Sweep/Incidence Wings ("Morphing")
6.3.4. Future of High-Speed Flight
6.4. Flight and Wind Tunnel Testing
6.4.1. Wind Tunnel Force and Moment Data
6.4.2. Compressibility Effects on Impact Pressure
6.4.3. Air Data Computation for Supersoinc Aircraft
6.5. Atmospheric Hazards to Flight

References

1. Stengel, R., Flight Dynamics, Princeton University Press, 2004.
2. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1982.
3. Babister, A.W., "Aircraft Dynamic Stability and Re¬sponse", Pergamon Press, Oxford, 1980.
4. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition, Issac Pitman, London, 1981

Practical
1. This course is the aircraft performance, stability, and control course which most directly prepares the student for the aircraft capstone design course. Topics covered in the first part of the course help the student identify the parameters which affect takeoff, climb, cruise, descent, turn, and landing performance as well as specific excess power. Topics covered in the second part of the course include a detailed look at static longitudinal stability, with special emphasis on cg location for static stability, and an overview of dynamic longitudinal stability and response to an elevator deflection and to a vertical gust .
2. MATLAB : Most of the computer exercises have been placed in the lab associated with the class. Some assignments require computation and plotting.

Evaluation Scheme:

The questions will cover all the chapters of the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	All	8
2	2	All	16
3	3	All	16
4	4	All	16
5	5 & 6	All	24
Total			80

FINITE ELEMENT METHOD
ME751

Lecture : 3 **Year : III**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:

To understand the basic steps of finite element methods, its applications and advantages. To develop the finite element model for discrete structural and non-structural problems and continuum problems specially heat transfer, plane elasticity.

To develop computer program and use commercial software for above mentioned problems.

1. Overview **(2 hours)**

1.1. Introduction
1.2. Brief history
1.3. Mathematical modeling of the physical system
1.4. FEM Analysis Process
1.5. FEM Steps
1.6. Applications of the Finite Element Method
1.7. Advantages of the Finite Element Method

2. Mathematical Background **(2 hours)**

2.1. Vector analysis
2.2. Matrix theory
2.3. Differential Equations

3. Direct Stiffness Method: Discrete Finite Elements **(8 hours)**

3.1. Spring/Bar Element
3.2. Truss Element
3.3. Beam Element
3.4. Frame Element
3.5. Analogous problems in one dimension

4. Continuum Problems **(8 hours)**

4.1. Ritz Method
4.2. Method of Weighted residuals
4.3. Strong and Weak formulation

5. Interpolation Functions **(10 hours)**

5.1. Piecewise defined functions
5.2. One dimensional element
5.3. Two dimensional element
    5.3.1. Triangular element
    5.3.2. Rectangular element
5.4. Variation approach

6. Applications in Solid Mechanics **(10 hours)**

6.1. Plane stress
6.2. Plane strain
6.3. 3 dimensional element
6.4. Axisymmetric stress analysis
6.5. Thermal stress analysis

7. Higher order Elements **(5 hours)**

7.1. Lagrange elements
7.2. Serendipity elements
7.3. Parametric Mapping

Practical:

1. Development of Computer programs for discrete structural problems (Bar, Truss, Beam and Frame).
2. Development of Computer program for discrete non-structural problems (Heat Transfer, Fluid Flow).
3. Development of Computer program for one dimensional continuum problems.
4. Development of Computer program for two dimensional continuum problems with one dependent variable.
5. Development of Computer program for two dimensional continuum problems with two dependent variables.
6. Development FEM model using parametric mapping.
7. Use of commercial software for heat transfer and stress analysis.

References:

1. D. L. Logan, “A First Course in the Finite Element Method”, Thomson India Edition.
2. D. V. Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw Hill Publishing Company Limited.
3. J. N. Reddy, “An Introduction to the Finite Element Method”, Tata McGraw Hill Publishing Company Limited.
4. A. Gilat, “MATLAB An Introduction with Applications”, Wiley India.

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the questions will be indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 7	All	16
2	3	All	16
3	4	All	16
4	5	All	16
5	6	All	16
Total			80

UNMANNED AIR VEHICLE SYNTHESIS
AE

Lecture : 3 **Year : III**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:

The course covers thefundamental principles related to UAV development, research and applications. It particularly focuses onthe research themes of the CREATE program including airframe optimization, control, autonomyand navigation, and sensory feedback for improved UAV pilot performance.

1. UAV Aerodynamics **(8 hours)**

1.1 Introduction
1.2 Coordinate systems used in flight mechanics and flight dynamics
1.3 Aerodynamics and Computational Fluid Dynamics
1.4 Experimental Aerodynamics and Flow Control for UAVs
1.5 Design Process
1.6 UAV Configuration

2. UAV Conceptual Analysis **(8 hours)**

2.1 Aerodynamic Analysis
2.2 Weight Estimation
2.3 Propulsion System Analysis
2.4 Wing Design
2.5 Detailed Design
2.6 Multi-funcitonal and micro-architectural lightweight structure for UAVs

3. UAV Dynamics and Control **(8 hours)**

3.1 Quadrotor dynamics and control
3.2 Fixed wing dynamics and control
3.3 Performance Analysis
3.4 Stability Analysis

4. UAV Navigation **(6 hours)**

4.1 UAV Control System
4.2 Navigation for UAVs
4.3 Path Planning for UAVs

5. UAV Autonomy **(8 hours)**

5.1 Equation of motion of the rigid-body aircraft
5.2 Sensing and Estimation for UAVs
5.3 Instrumentation and Sensor Payloads for UAVs
5.4 Computer Vision for UAVs

6. UAV Performance and Design **(7 hours)**

6.1 Remotely Piloted UAV operation

6.2 Performance and Design Aspects

Practical:
For either fixed wing or rotorcraft UAVs, create a motion planning algorithm to avoid obstacles in a continuously updated map of the environment. Limit current map visibility to a fixed range and field of view of the sensors, and identify efficient strategies that can be updated in real time. Consider always planning a safe holding pattern, and demonstrate the algorithm on forest or urban environments.

References:
1. Nelson, R. C. Flight Stability and Automatic Control, McGraw-Hill, Inc. 1989.
2. McLean, D. Automatic Flight Control Systems, Prentice-Hall, International Ltd., 1990.
3. Blakelock, J. H. Automatic Control of Aircraft and Missiles, John Wiley & Sons, Inc., 1991.
4. Dorf, R.C. – Bishop, R.H. Modern Control Systems, Prentice-Hall International Inc., 2011.

Evaluation Scheme:
There will be questions covering all the chapters in the syllabus. The evaluation scheme for the questions will be indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1	All	16
2	2	All	16
3	3 & 4	All	16
4	5	All	16
5	6	All	16
Total			80

AIRCRAFT MAINTENANCE ENGINEERING
AE

Lecture : 4 **Year : III**
Tutorial: 0 **Part : II**
Practical : 3/2

Course Objectives: To have brief understanding of Development Maintenance in Aviation Sector

1. Why do have to do Maintenance? (4 Hours)

1.1 Introduction
1.2 Thermodynamics Revisited
1.3 Roles of Engineer and Mechanic
1.4 Maintenance Types
1.5 Reliability
1.6 Redesign
1.7 Failure Rate Patterns
1.8 Maintenance Considerations
1.9 Maintenance Program Establishment

2. Development of Maintenance Program (4 Hours)

2.1 Introduction
2.2 Maintenance Steering Group
2.3 Process Oriented Maintenance
2.4 Task Oriented Maintenance
2.5 MSG-3
2.6 Maintenance Program Documents
2.7 Maintenance Interval Defined
2.8 Changing Basic Maintenance Intervals

3. Definition Goals and Objectives (4 Hours)

3.1 Definition
3.2 Maintenance
3.3 Inherent Reliability
3.4 Mechanics, Technicians, Maintainers, Engineer
3.5 Word Pairs used in Aviation
3.6 Goals and Objectives is Maintenance
3.7 Maintenance Program Content
3.8 Discussion of 5 Objectives

4. Aviation Industry Certification Requirement (4 Hours)

4.1 Introduction
4.2 Aircraft Certification
4.3 Delivery Inspection
4.4 Operator Certification
4.5 Certification of Personnel
4.6 Aviation Maintenance Certification
4.7 Aviation Industry Interaction

5. Documentation for Maintenance **(2 hours)**

5.1 Introduction
5.2 Manufactures Documentation
5.3 Regulatory Documentation
5.4 Airline Generated Documentation
5.5 ATA Document Standard
5.6 A closer look at TPPM

6. Maintenance and Engineering Organization **(5 Hours)**

6.1 Organization of Maintenance and Engineering FAA and EASA
- 6.1.1 Organizational Structure
- 6.1.2 General Grouping (CAMO& AMO)
- 6.1.3 Manager Level Function- Technical Services, Overhaul Shops, Material, Maintenance Program, aircraft Maintenance
- 6.1.4 Organization Structure and the TPPM
- 6.1.5 Variation from the Typical Organization

6.2 Maintenance Program (AMP)
- 6.2.1 Introduction
- 6.2.2 Maintenance Program Outlined
- 6.2.3 Summary of FAA and EASA requirements
- 6.2.4 Additional Maintenance Program Requirement

7. Engineering and Production Planning **(5 hours)**

7.1 Makeup Engineering
- 7.1.2 Mechanics and Engineering
- 7.1.3 Engineering and Department Function
- 7.1.4 Engineering Order Preparation

7.2 Production Planning and Control
- 7.2.1 PP & C Organization
- 7.2.2 Function
- 7.2.3 Production Planning
- 7.2.4 Production Control
- 7.2.5 Other Scheduled Work
- 7.2.6 Feedback for Planning

8. Technical Publication and Training **(3 Hours)**

8.1 Technical Publication
- 8.1.1 Functions of Technical Publication
- 8.1.2 Airline Libraries
- 8.1.3 Control of Publications
- 8.1.4 Document Distribution

8.2 Technical Training
- 8.2.1 Training Organization
- 8.2.2 Airlines Maintenance Training
- 8.2.3 Maintenance Resource Management
- 8.2.4 Airframe Manufacturer’s Training Courses

8.2.5 Supplemental Training

9. Aircraft Maintenance Management **(2 Hours)**

9.1 Aircraft Maintenance Management Structure
9.2 Role of Management
9.3 Manager of Aircraft Maintenance
9.4 Front line supervisor/management
9.5 Manager for Overhaul Shops

10. Line and Hangar Maintenance **(10 Hours)**

10.1 Line Maintenance
10.1.1 Functions that control Maintenance
10.1.2 Maintenance Control Center (MCC)-Responsibilities
10.1.2 Line Maintenance Operation
10.1.3 Aircraft Logbook
10.1.4 Ramp and Terminal Operation
10.1.5 Line Station Activities
10.1.6 Maintenance Crew Skill Requirement
10.2 HangarMaintenance
10.2.1 Organization of Hangar Maintenance
10.2.2 Problem Areas in Hangar Maintenance
10.2.3 Hangar Maintenance Activity- C Check
10.2.4 Morning Meetings
10.2.5 Support and Overhaul Shops
10.2.6 Ground Support Equipment (GSE)
10.2.7 Outsourcing of Shop Maintenance Work
10.2.8 Shop Data Collection

11. Material Support **(2 Hour)**

11.1 Organization and Function of Material
11.2 Material Management
11.3 Support Function of Material
11.4 Other Material Function

12. Quality Assurance and Control **(2 hours)**

12.1 Requirement of Quality Assurance (QA)
12.2 Quality Audits
12.3 ISO 9000 Quality Standard
12.4 Other Function of QA
12.5 Quality Control Organization
12.6 FAA and EASA Differences
12.7 QC Inspection Qualification
12.8 Basic Inspection Policies

13. Reliability and Maintenance Safety **(8 Hours)**

13.1 Reliability

13.1.1 Types of Reliability
13.1.2 A reliability Program
13.1.3 Elements of Reliability Program
13.1.4 Other Functions of Reliability Program
13.1.5 Administration and Management of the Reliability Program

17.2 Maintenance Safety
13.2.1 Industrial Safety
13.2.2 Safety Regulation (SMS)
13.2.3 Maintenance Safety Program
13.2.4 General Responsibilities of Safety
13.2.5 General Safety Rules
13.2.6 Reporting

14. Systems Engineering (2 Hours)

14.1 Systematics versus System Approach
14.2 Systems Engineering
14.3 Definitions
14.4 System Interface Control
14.5 System Optimization

15. ETOPS (Extended Twin Engine Operations) (3 Hours)

15.1 Background
15.2 Deviation from the 60 Minute Rules
15.3 ETOPS Maintenance vs Conventional Maintenance
15.4 ETOPS for Non-ETOPS Airplanes
15.5 Polar Operations (FAA and EASA)
15.6 Polar Areas

Practical:

1. Industrial Visit and prepare case report.

References:

1) FAA Advisory Circulars
2) EASA Part M, Part 145, Part 21, Part 66
3) ICAO Annex 19
4) NCAR Part 66, 145,147

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the questions will be indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 3	All	16
2	4, 5 & 6	All	16
3	7, 8 & 12	All	16
4	10 & 11	All	16
5	13, 14 & 15	All	16
Total			80

Syllabus

Year - IV, Part - I

Bachelors of **Aerospace Engineering**

Department of Mechanical Engineering

Institute of Engineering

Pulchowk Campus

Tribhuvan University

Date: 31/02/2075

AIRCRAFT PRELIMINARY DESIGN
AE

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives:

The course should enable the students to: understand the basic types and configurations of aircraft layouts, maneuvering loads on tail planes, know the different types of power plant and characteristics of propeller and its configurations, know the basic manoeuvers such as gliding flight and calculations of takeoff and landing, know the layout of special design and specifications of aircraft, understand the structural design of fuselage, wing and other aircraft parts.

1. Introduction **(4 hours)**

- 1.1 Engineering Design
- 1.2 Aircraft Design Process
- 1.3 Aircraft Conceptual Design Synthesis Process
- 1.4 Aircraft Configuration
    - 1.4.1 Conventional Configuration
    - 1.4.2 Alternative Configuration
    - 1.4.3 Creativity and Configuration Design
- 1.5 Design Considerations

2. Power Plant Types and Characteristics **(6 hours)**

- 2.1 PowerplantCharacteristics
- 2.2 Types of power plants
- 2.3 Typical Engine Parameters
- 2.4 Flight Regimes of Powerplants
- 2.5 Powerplant Performance Representation
- 2.6 Typical Aircraft Installed Thrust Power

3. Preliminary Design **(8 hours)**

- 3.1 Fuselages Layout
    - 3.1.1 Function of Fuselage
    - 3.1.2 Primary Considerations
    - 3.1.3 Overall Layout
    - 3.1.4 Local Layout Aspects
    - 3.1.5 Crew and Payload
    - 3.1.6 Fuselage Layout Procedure
- 3.2 Airfoil Design
- 3.3 Planform Shape and Geometry
- 3.4 High Lift Devices

4. Lift, Drag and Mass Estimation **(3 hours)**
5. Performance Estimation **(4 hours)**
6. Optimization **(8 hours)**

6.1 Cost and Optimization
6.2 Parametric Analysis and Optimization
6.3 Case Study (Stage 1)
6.4 Procedure for Stage 2
6.5 Case Study (Stage 2)
6.6 Wing Location and Control Surface

7. Refinement and Analysis Concept (4 hours)
8. Landing Gear (3 hours)
9. Aerodynamic Optimization (5 hours)

References

1. G. Corning, "Supersonic & Subsonic Airplane Design", II Edition, Edwards Brothers Inc., Michigan, 1953.
2. E.F. Bruhn, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., U.S.A., 1980.
3. A.A. Lebedenski, "Notes on airplane design", Part-I, I.I.Sc., Banglore, 1971.
4. E. Torenbeek, "Synthesis of Subsonic Airplane Design", Delft University Press, London, 1976.
5. D.P. Raymer, "Aircraft Conceptual Design", AIAA Series 1988.
6. H.N. Kota, "Integrated design approach to Design fly by wire" Lecture notes Interline Pub. Banglore, 1992.
7. S.C. Keshu& K.K. Ganapathi, "Aircraft Production Techniques and Management", 1995.

Practical:
1. Conceptual design of an aircraft for a given mission.
2. Write synopsis on aircraft design research article (article can vary students to student).

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1 & 2	All	16
2	3 & 4	All	16
3	5 &7	All	16
4	6	All	16
5	8 & 9	All	16
Total			80

COMPUTATIONAL FLUID DYNAMICS
AE

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 3/2
Course Objectives:

1. Introduction to CFD **[4 hours]**

1.1 What is computational fluid dynamics?
1.2 Basic principles of CFD
1.3 Stages in a CFD simulation
1.4 Fluid-flow equations
1.5 The main discretisation methods
1.6 Exercises

2. Fluid-Flow Equations **[6 hours]**

2.1 Introduction
2.2 Conservative differential equations
2.3 Non-conservative differential equations
2.4 Non-dimensionalisation
2.5 Exercises [Numerical Problems]

3. Approximations and Simplified Equations **[8 hours]**

3.1 Steady-state vstime-dependent flow
3.2 Two-dimensional vs three-dimensional flow
3.3 Incompressible vs compressible flow
3.4 Inviscidvs viscous flow
3.5 Hydrostatic vs non-hydrostatic flow
3.6 Boussinesq approximation for density
3.7 Depth-averaged (shallow-water) equations
3.8 Reynolds-averaged equations (turbulent flow)
3.9 Examples

4. The Scalar-Transport Equation **[8 hours]**

4.1 Control-volume notation
4.2 The steady-state 1-d advection-diffusion equation
4.3 Discretising diffusion
4.4 Discretising the source term
4.5 The matrix equation
4.6 Discretising advection (part 1)
4.7 Extension to 2 and 3 dimensions
4.8 Discretisation properties
4.9 Discretising advection (part 2)
4.10 Implementation of advanced advection schemes
4.11 Boundary conditions
4.12 Solution of matrix equations
4.13 Examples [Numerical Problems]

5. Pressure and Velocity **[6 hours]**

5.1 The momentum equation
5.2 Pressure-velocity coupling
5.3 Pressure-correction methods
5.4 Exercise [CFD Simulation in Software _ Tutorial Exercise]

6. Turbulence **[8 hours]**

6.1 What is turbulence?
6.2 Momentum transfer in laminar and turbulent flow
6.3 Turbulence notation
6.4 Effect of turbulence on the mean flow
6.5 Turbulence generation and transport
6.6 Important shear flows
6.7 Exercise [CFD Simulation in Software _ Design Problem]

7. Pre- and Post-processing **[5 hours]**

7.1 Stages of a CFD analysis
7.2 The computational mesh
7.3 Boundary conditions
7.4 Flow visualization

Laboratories:

CFD Analysis in OpenFoam/Ansys
1. Simulation of vortex shredding over a cylinder
2. Simulation of air flow over an airfoil
3. Use of UPWIND, CENTRAL Difference scheme for scalar advection-diffusion problem.

Reference:

1. An introduction to Computational Fluid Dynamics – The Finite Volume Method, H. K. Versteeg and W. Malalasekera
2. Computational Methods for Fluid Dynamics – Joel H. Ferziger/MilovanPeric
3. Computational Fluid Dynamics: Principles and Applications, J. Blazek
4. Computational Fluid Dynamics – The Basics with Applications, John D. Anderson, Jr.
5. The Physics of Fluid Turbulence – W. D. Mc COMB

Text Book

1. Computational Fluid Dynamics – The basics and applications, Anderson J.D. Jr, (1995), Mcgraw-Hill, New York.
2. An introduction to CFD, H. Versteeg and W. Malalasekra, Pearson, Education, 2nd Edition, 2008. Reference Book
3. Computational Fluid Dynamic – a practical approach, JiyuanTu, Guan HengYeoh and Chaoqun Liu, Butterworth-Heinemann (ELSEVIER), 2008.
4. Introduction to Computational Fluid Dynamics, PradipNiyogi, S.K. Chakrabarthy and M.K. Laha, Pearson Education, 2006.

Evaluation Scheme:
There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	All	16
2	3	All	16
3	4	All	16
4	5 & 7	All	16
5	6	All	16
Total			80

AIRCRAFT STRUCTURES
AE

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives:

To provide students a sound knowledge of Civil Aircraft structure design criteria and in-depth knowledge on design process.

1. Introduction to Aircraft Structural Design (6 hours)

1.1 Structural layout of the Airplane and components,
1.2 Structural design V-n diagram
1.3 loads acting on majorcomponents such as
  1.3.1 Wing
  1.3.2 Fuselage
  1.3.3 Tails
  1.3.4 Landing gear etc.
1.4 Concept of allowable stress and margin of safety.

2. Unsymmetrical Bending (6 hours)

2.1 Bending stresses in beams of unsymmetrical sections
2.2 Bending of symmetric sections with skew loads

3. Shear Flow in Open Sections (6 hours)

3.1 Thin walled beams,
3.2 Concept of shear flow,
3.3 Shear center, Elastic axis.
  3.3.1With one axis of symmetry,
  3.3.2 With walleffective and ineffective in bending,
  3.3.3 Unsymmetrical beam sections.

4. Shear Flow in Closed Sections (10 hours)

4.1 Bredt‐Batho formula,
4.2 Single and multi ‐ cell structures
  4.2.1 Approximate methods
  4.2.2 Shear flow in single & multi-cellstructures under torsion.
4.3 Shear flow in single and multi-cell under bending with walls effective and ineffective.

5. Buckling of Plates (6 hours)

5.1 Rectangular sheets under compression
5.2 Local buckling stress of thin walled sections
5.3 Crippling stresses byNeedham's and Gerard's methods
5.4 Thin walled column strength
5.5 Sheet ‐ stiffener panels
5.6 Effective width, inter-rivet and sheet wrinkling failures

6. Joints and Fittings And Introduction to Post Buckling (6 hours)

6.1 General theory for the design of fittings,
6.2 Estimation of fitting design loads,
6.3 Design of riveted, bolted and weldingjoints,
6.4 Post buckling of structures,
6.5 Concept of effective width.

7. Stress Analysis in Wing and Fuselage **(10 hours)**

7.1 Procedure ‑

7.1.1 Shear and bending moment distribution for semi cantilever and other types of wings andfuselage,
7.1.2 Thin webbed beam.
7.1.3 With parallel and non-parallel flanges,
7.1.4 Shear resistant web beams,
7.1.5 Tensionfield Web beams (Wagner’s).

8. Design of Aircraft Structure **(9 hours)**

8.1 Design criteria
8.1.1 Safety Factor
8.1.2 Design life criteria
8.2 Analysis method
8.2.1 Life Assessment procedures
8.3 Design Principle
8.3.1 FutureAirworthinessRequirements
8.3.2 Two bay crack criteria
8.3.3 Widespread Fatigue damage

Practical:

1. Wind/Fuselage/Empennage Design project for UAVs and use various criteria to determine safety.
2. Experimental validation of stiffened plate deformation.

Text Books:

1. Megson, T.M.G., “Aircraft Structures for Engineering Students”, Edward Arnold, 1995.
2. Peery, D.J., andAzar, J.J., “Aircraft Structures”, 2nd edition,McGraw‑Hill, N.Y., 1993.

Reference:

1. Bruhn. E.H. “Analysis and Design of Flight vehicles Structures”, Tri‑state off set company, USA, 1985.
2. Rivello, R.M., “Theory and Analysis of Flight Structures”, McGraw- Hill, 1993.
3. D Williams &Edward Arnold, “An Introduction to the Theory of Aircraft Structures”.

Evaluation Scheme:
There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	All	16
2	2, 3& 4	All	16
3	5 & 6	All	16
4	7	All	16
5	8	All	16
Total			80

EMBEDDED SYSTEMS IN AVIONICS
AE

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 2

Course Objectives:

This practical, hands-on course introduces the various building blocks and underlying scientific and engineering principles behind embedded systems. The course covers the integrated hardware and software aspects of embedded processor architectures, along with advanced topics such as real-time, resource/device and memory management.

1. Introduction **(5 hours)**

1.1 Course Overview
1.2 ARM Architecture
1.3 ARM asm Overview

2. Components **(6 hours)**

2.1 Memory Mapped I/O and Buses
2.2 Serial Protocols
2.3 Timers and Interrupts

3. ARM **(6 hours)**

3.1 ARM Profiling and Optimization
3.2 ARM SWI
3.3 Sampling, ADCs, DACs

4. Sensors and Actuators **(4 hours)**

5. Scheduling **(8 hours)**

5.1 Processors
5.2 Scheduling and Concurrency
5.3 Real-Time Scheduling 1-2
5.4 Real-Time Scheduling 2-2

6. Embedded System Design **(10 hours)**

6.1 Design Review
6.2 Embedded Linux
6.3 Multi-Core and SoC
6.4 Embedded Power Management
6.5 Embedded Control

7. Communication System **(6 hours)**

7.1 Real-Time Communication
7.2 Embedded Wireless Communication
7.3 Security for Embedded Systems

Practical:
1. PCB Design and Manufacturing

References:
1. Hermann Kopetz, "Real-Time Systems: Design Principles for Distributed Embedded Applications". Kluwer, 1997
2. Jon S. Wilson, "Sensor Technology Handbook", Newnes, ISBN 0750677295, 704 pages, 2004.

Evaluation Scheme:
There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	All	16
2	3 & 4	All	16
3	5	All	16
4	6	All	16
5	7	All	16
Total			80

AIR TRAFFIC MANAGEMENT
AE

Lecture : 4 **Year : IV**
Tutorial : 0 **Part : I**
Practical : 3/2

Course Objectives: To have brief understanding of Air Traffic Services around the globe.

1 Air Traffic Services **(4 Hours)**

1.1 Introduction
- 1.1.1Language Requirement
- 1.1.2 Air Traffic Services
- 1.1.3 Objectives of Air Traffic Services
- 1.1.4 Air Traffic Control Services
- 1.1.5 Air Traffic Advisory Service
- 1.1.6 Flight Information Service
- 1.1.7 Alerting Services
- 1.1.8 Air Traffic Control Units

2 Flight Rules **(4 Hours)**

2.1 Airspace
- 2.1.1 Airspace Division
- 2.1.2 Airspace Classification
- 2.1.3 Speed Limit
- 2.1.4 Visual Flight Rules (VFR)
- 2.1.5 Aerodrome Traffic Zone (ATZ)
- 2.1.6 Cancellation of Instrumental Flight Rules (IFR) Flight
- 2.1.7 Special VFR Flight
- 2.1.8 Class C Airspace

2.2 Flight Plan
- 2.2.1 Filing of Flight Plans
- 2.2.2 Non Standard Routes
- 2.2.3 Repetitive Flight Plan
- 2.2.4 Availability of Supplementary Flight Plan Information
- 2.2.5 Booking Out
- 2.2.6 Exemption and Non Standard Flights
- 2.2.7 Aircraft Proximity (AIRPROX)
- 2.2.8 Search Action
- 2.2.9 Failure of Navigation Lights
- 2.2.10 Operation of Aircraft with Unserviceable Equipments
- 2.2.11 Radio Mandatory Zone

3 Separation Standard **(4 Hours)**

3.1 Definition

3.2 Provision of Standard Separation

3.3 Separation types
- 3.3.1 Increased Separation
- 3.3.2 Reduced Separation
- 3.3.3 Vertical Separation

3.3.4 Horizontal Separation
3.3.5 Lateral Separation
3.3.6 Longitudinal Separation- Time and Distance
3.4 Essential Traffic Information
3.5 Wake turbulence Separation Requirement
3.6 Separation Based on ATS Surveillance System Information

4 Control of Traffic **(4 Hours)**

4.1 Clearances
4.1.1 Air Traffic Control Clearances
4.1.2 Contents of Clearance
4.1.3 Clearance Limit
4.1.4 Route
4.1.5 Allocation of Cruise Levels
4.1.6 Amendments to Clearances
4.1.7 Withholding Clearances
4.2 Data Display and Flight Priorities
4.3 Notification of Flights
4.4 Transfer of Control
4.5 Time
4.5.1 EAT
4.5.2 CTOT
4.6 GPWS
4.7 Non Deviation Status (NDS)
4.8 Unusual Aerial Activity

5 Integration of VFR with IFR in Class D CTR/CTA/TMA **(2 hours)**

5.1 Introduction
5.2 Flight Rules
5.3 Control of VFR Flight

6 ATS Surveillance Systems **(5 Hours)**

6.1 Services
6.2 Penetration by Independent Units
6.3 Identification
6.3.1 PSR
6.3.2 SSR-MODE A
6.3.3 SSR-MODE S
6.3.4 Transponder Mandatory Zone (TMZ)
6.3.5 Transfer of Identity
6.3.6 Lost Identity
6.3.7 Identification and Position Information
6.4 Use of Mode C for Vertical Separation
6.4.1 Radar Handover and Release
6.5 Vectoring
6.6 Terrain Clearance

6.7 Unknown Aircraft
6.8 Traffic Information to Aircraft
6.9 Weather Avoidance
6.10 Display
6.10.1 Clutter on the Situation Display
6.10.2 Situation Display Serviceability
6.10.3 STCA Procedures

7. ACAS, Traffic Information and Co-ordination between ATS Personnel, Speed Control (5 hours)

7.1 ACAS
7.1.1Introduction
7.1.2TCASII Warning System
7.1.3Nuisance Advisories
7.1.4 Departure from ATC Clearance
7.1.5 TCAS Phraseology
7.1.6 Controller Reporting
7.2 Information and Coordination
7.2.1 Traffic Information
7.2.2Coordination
7.2.3 Verbal Procedure
7.2.4Coordination of Climbing/ Descending Aircraft
7.2.5 Airspace Penetration
7.2.6 Consideration for Traffic Receiving a service quality outside controlled airspace.
7.3 Speed Control
7.3.1 General
7.3.2 Arrivals and Descending Aircraft
7.3.3 Departing Aircraft
7.3.4 Speed Control Phraseology and Additional Guidance.

8. Airport Considerations (8 hours)

8.1 Aerodome Lightening Aids
8.2 Light Signal and Pyrotechnics
8.3 Windshear
8.4 Prevailing Visibility
8.5 Wet Runways

9. Air Traffic Considerations (12 hours)

9.1 Approach Control
9.2 Approach Radar
9.3 Runway Visual Range
9.4 Area Control Procedures
9.5 Flight Information Service at Area Control Centers
9.6 Meteorological Information and Services

10. Aircraft Emergencies (12 hours)

10.1 Radio Failure

10.2 Aerodrome Emergency Services
10.3Aircraft Accident, Incident and AIRPROX Reports
10.4 Bird Strikes

Practical:
Visit to airport and study various components of the air traffic and airport management system. Prepare a report on cases observed.

References:

1. Manual of Air Traffic Services - Part 1, CAP 493
2. Dr. Andrew Cook, European Air Traffic Management, Ashgate Publishing 2007
3. Michael S. Nolan, Fundamentals of Air Traffic Control, Delmar Cengage Learning, 5th Edition

Evaluation Scheme:
There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1, 2 & 3	All	16
2	4, 5 & 6	All	16
3	7 & 8	All	16
4	9	All	16
5	10	All	16
Total			80

Syllabus

Year - IV, Part - II

Bachelors of **Aerospace Engineering**

Department of Mechanical Engineering

Institute of Engineering

Pulchowk Campus

Tribhuvan University

Date: 31/02/2075

Aviation Professional Practices
AE

Lecture: 2 **Year: IV**
Tutorial: 0 **Part: II**
Practical: 0

Course objective:

The student should know the general principles those forbid or require various kinds of action in engineering. Throughout the course, emphasis will be placed on learning how to criticize and evaluate moral and philosophical claims, as well as developing and deepening one's own views.

1. Brief introduction of Professional Ethics (3 hours)

What is Ethic? Why study ethic? What is Professional Ethics, and what is a worker's rules or standards that he should do and not do in the working or in the workplace.

2. Cherishing the job devotionally (4 hours)

Love professionals and respect their jobs. Further speaking: in workplace, Keeping honesty and credit, cherishing the job devotionally, uniting each other, making pioneering efforts.

3. Honesty (4hours)

Honesty means no telling lies. Companies have an obligation to provide customers with the information they need to make informed choices. Telling the whole truth may mean losing a sale, but it is less costly in the long run than losing customer's loyalty.

4. Justness (6 hours)

When Interests Collide happen what a worker should do.

5. Cooperation (5hours)

It includes two parts: 1) Why cooperate? 2) Cooperation vs competition

6. Engineering Ethic (4hours)

Engineering ethic is the field of applied ethicswhich examines and sets standards forengineers' obligations to the public, their clients, employers and the profession.

7. Science Ethic (4hours)

The basic goal of science is to cognize the world and to discover new truths of phenomena and processes. The process of scientific cognition should be based on ethical principles of both research and discussion defined.

References:

1. Elizabeth A Hoppe, Ethical Issues in Aviation, Ashgate
2. Amy L. Fraher, The Next Crash: How Short-Term Profit Seeking Trumps Airline Safety, Cornell University Press, 2014
3. Andrew R. Thomas, Soft Landing: Airline Industry Strategy, Service, and Saftey, Apress, 2011

Evaluation Scheme:
There will be questions covering all the chapters of the syllabus. The evaluation scheme will be indicated in the table below:

Unit	**Chapter**	**Topics**	**Marks**
1	1 & 2	All	8
2	2	All	8
3	3	All	8
4	4	All	8
5	5	All	8
Total			40

INTERNSHIP
AE

Attachment: 2-3 Months **Year : IV**
Part: II

Course Objective:
To visit and work in different kinds of aviation industries in the country. To study the existing management system and technology of that industry.

General Procedures:
Students in groups will be placed in different industries for the duration of two weeks during vacation. They will be assigned to perform available work in the industry supervised by the assigned engineer/technician from the industry.
After the completion of their attachment each group has to submit the report in writing and give presentation to the committee formed by the department.

The report should include technical as well as managerial part of the industry.

Evaluation Scheme:
The evaluation scheme will be indicated in the table below:

	Marks
Evaluation by Supervisor from Industry	60
Evaluation of Written Paper	30
Evaluation by Supervisor from University	60
Presentation	50
Total	**200**

Elective Streamline:

Maintenance Engineering

Bachelors of Aerospace Engineering

FLEET PLANNING FOR AIRLINES
AE

Lecture : 3 **Year : III**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:
To conceptualize and visualize the process of fleet planning as applied to scheduled airlines operating aircraft.

1. Introduction **(7 Hours)**
- 1.1 Fleet Planning- Introduction
- 1.2 Role of Manufacture in Fleet Planning
- 1.3 Resolving conflicts of Time Perspective in Fleet Planning
- 1.4 Coping with the Cycle
- 1.5 The Problem of Stored Aircraft
- 1.6 Size Matters
- 1.7 Anatomy of a Campaign

2. Fleet Selection Process **(5 Hours)**
- 2.1 Valuing the Assets
- 2.2 Defining overall objectives and Goals
- 2.3 Good Fleet Plan
- 2.4 Key Decision Criteria
- 2.5 Trends in Tools and Data

3. The Market Evaluation **(8 Hours)**
- 3.1 Setting the Scene
- 3.2 Measuring Production
- 3.3 Macro and Micro Approach to Fleet Planning
- 3.4 Market Segmentation and Spill
- 3.5 Modeling on Single Sector and Network
- 3.6 The Micro Network Model
- 3.7 The Network Matrix
- 3.8 Market Share Modeling

4. The Aircraft and Airline Product **(4 Hours)**
- 4.1 Getting prepared to conduct the evaluation
- 4.2 The Aircraft and Airline Product
- 4.3 Defining the Aircraft Configuration
- 4.4 Principles of Aircraft Specification and Customization

5. Aircraft Performance **(8 Hours)**
- 5.1 Importance of Aircraft Performance
- 5.2 Background and Certification Process
- 5.3 Aircraft Weight Build Up
- 5.4 Building the Payload Range

5.5 The Airfield Performance Analysis
5.6 The En-route performance Analysis
5.7 Combining the probabilities
5.8 Aircraft Selection

6. Aircraft Economics **(6 Hours)**

6.1 Importance of Aircraft Economics
6.2 Cost Classification and Components
6.3 Cost and Revenue Management- Methods
6.4 Dynamic Fleet Management
6.5 Drivers of Aircraft Operating Economics
6.6 Spares Provisioning

7. The Investment Appraisal **(5 Hours)**

7.1 Drawing the Threads together
7.2 Impact of Aircraft Price
7.3 Scope of Investment Appraisal
7.4 Residual Values
7.5 Choosing the right decision tool
7.6 Judgment and Decision Making

8. Conclusion **(2 Hours)**

8.1 Fleet Planning- Art or Science?

References:

1. Buying the Big Jets, Second Edition, by Paul Clark, Ashgate,
2. John E. Dolce, Analytical Fleet Management , 3rd Edition SAE International
3. Crainic, Teodor G., Laporte, Gilbert, Fleet Management and Logistics,

Practical

1. Industry visit to various Aircraft Operation Department and observe and discuss the various procedures involved in fleet planning and prepare a report. Report criteria to be discussed in the class.
2. Detailed Case Study of specific airline fleet and their planning structure.

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1 & 2	All	16
2	3	All	16
3	4 & 6	All	16
4	5	All	16
5	7 & 8	All	16
Total			80

Human Reliability, Error and Factor in Aviation
AE

Lecture : 3 **Year : III**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives: To understand the Importance of Human Related Errors and its solution in aviation maintenance.

1. Introduction **(2 Hours)**

1.1 Background
1.2 History
1.3 Human Reliability, Error and Factor: Facts and Figure
1.4 Terms and Definitions
1.5 Human Reliability, Error and Factor: Useful Information

2. Basic Mathematical Concept **(5 Hours)**

2.1 Introduction
2.2 Boolean Algebra Laws and Probability Properties
2.3 Useful Definition
2.4 Probability Distribution
2.5 Solving First Order Differential Equation

3. Introductory Human Factors, Reliability and Error Concepts **(10 Hours)**

3.1 Introduction
3.2 Human Factor Objectives and Man- Machine System Types and Comparisons
3.3 Human Sensory Capacities and Typical Human Behavior and their corresponding design consideration
3.4 Human Factors Related Formula
3.5 Useful Human Factors Guidelines and Data Collection Sources
3.6 Human Performance Effectiveness and Operator Stress Characteristics
3.7 Operational Stressor and General Stress Factors
3.8 Human Performance Reliability and Correct ability Functions
3.9 Human Error occurrences reasons, consequences, ways and classification
3.10 Human Reliability and Error Data Collection Sources and Quantitative Data

4. Methods for Performing Human Reliability and Error Analysis in Aviation Maintenance (7 Hours)

4.1 Introduction
4.2 FMEA
4.3 Man Machine Systems Analysis
4.4 RCA
4.5 Error Caused Removal Program (ECRP)

4.6 Ishikawa (Fishbone Diagram) Cause and Effect
4.7 Probability Tree Method
4.8 Fault Tree Analysis
4.9 Markov Method

5. Human Error in Maintenance **(6 Hours)**

5.1 Introduction
5.2 Occurrence of Maintenance Error in Equipment life Cycles and Elements of a Maintenace
Persons Time
5.3 Maintenance Environment and Causes for the occurrence of Maintenance Errors
5.4 Types of Maintenance Errors
5.5 Common Maintainability Design Errors and Useful Design Improvement Guidelines to Reduce equipment errors
5.6 Maintenance Work Order (Instructions)
5.6 Maintenance Error Analysis Methods

6. Human Factors in Aviation Maintenance **(7 Hours)**

6.1 Introduction
6.2 The need for Human Factors in Aviation Maintenance and Its Impact
6.3 Human Factors in Aviation Maintenance: Challenge
6.4 Practical Guide Human Factor: Aviation Maintenance
6.5 Integrated Maintenance Human Factor Management System (IMMS)
6.6 Training Program and Areas for Human Factor: Aviation Maintenance
6.7 Regulatory Requirement: Human Factor in Aviation

7. Human Error in Aviation Maintenance **(8 Hours)**

7.1 Introduction
7.2 Facts and Figures
7.3 Causes of Human Error in Aviation Maintenance
7.4 Major Categories of Human Errors in Aviation Maintenance and Inspection Tasks
7.5 Common Human Errors in Aircraft Maintenance Activities
7.6 Aircraft Maintenance Error Analysis Methods
7.7 Maintenance Error Decision Aid (MEDA)
7.8 Guidelines for Reducing Human Error
7.9 Case Studies in Human Error: Aviation Maintenance: British Airways, Continental Express Aloha Airlines.

8. Safety **(7 Hours)**

8.1 Introduction
8.2 Facts and Figures
8.3 Causes of Maintenance Safety Problems and Factors.

8.4 Factors Influencing Safety Behavior and Culture in Maintenance Personnel
8.5 Good Safety Related Practices and Measures
8.6 Safety Question: Manufacturers
8.7 Guidelines for Aircraft Engineering Designers to Improve Safety in Maintenance

9. Mathematical Model for Performing Human Reliability and Error Analysis (5 Hours)

9.1 Introduction
9.2 Models for Predicting Maintenance Personnel Reliability in Normal and Fluctuating Environment
9.3 Models for Performing Single System Maintenance Error Analysis
9.4 Models for Performing Redundant Systems Maintenance

References:

1. B.S. Dhillon, Human Reliability, Error, and Human Factors in Engineering Maintenance: with reference to aviation and power generation, CRC Press
2. B.S. Dhillon, Human Reliability, Pergamon

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1, 2 & 8	All	16
2	3	All	16
3	4	All	16
4	5 & 6	All	16
5	7 & 9	All	16
Total			80

Aviation Legislation
AE

Lecture : 3 **Year : IV**
Tutorial: 1 **Part : II**
Practical : 3/2

Course Objectives: To have brief understanding of Aviation Regulation followed around the world

1. Regulatory Framework **(15 Hours)**

- 1.1 Introduction
  - 1.1.1 International Civil Aviation Organization (ICAO), International Air Transport Association (IATA) and Its roles
  - 1.1.2 The Convention of ICAO
  - 1.1.3 ICAO Annexes
  - 1.1.4 Role of Civil Aviation Authority of Nepal
  - 1.1.5 Civil Aviation Act 1959 and subsequent amendments
  - 1.1.6 Civil Aviation Authority Act 1996 and subsequent amendments
  - 1.1.7 Civil Aviation Rules 1996 and subsequent amendments
  - 1.1.8 Civil Aviation Authority Regulation 2002 and subsequent amendments
  - 1.1.9 General Introduction FAA and EASA
- 1.2 Certifying Staff
  - 1.2.1 Understanding of EASA Part 66
  - 1.2.2 Detailed Understanding of NCAR Part 66
- 1.3 Approved Maintenance Organization
  - 1.3.1 Understanding of EASA Part M subpart F and Part 145
  - 1.3.2 Detail Understanding of NCAR Part 145 and NCAR Part M

2.Operation- Commercial Air Transportation **(10 Hours)**

- 2.1 General Understanding of EU-Operations
- 2.2 Air Operator Certificates and its requirement
- 2.3 Operator Responsibilities- CAMO and AMO
- 2.4 Aircraft Maintenance Program (AMP)
- 2.5 Minimum Equipment List and Configuration Deviation List (MEL/CDL)
- 2.6 Documents to be carried on board the aircraft
- 2.7 Aircraft Placarding (Marking) Requirement

3.Aircraft Certification **(8 Hours)**

- 3.1 General
  - 3.1.2 Design Organization Part 21 (EASA and NCAR)
  - 3.1.3 Certification Rules: Type Certificates and Supplemental Type Certificates
- 3.2 Documents
  - 3.2.1 Certificate of Airworthiness
  - 3.2.2 Certificate of Registration
  - 3.2.3 Noise Certificate
  - 3.2.4 Weight Schedule

3.2.5 Radio Station License

4.Applicable National and International Requirement (12 Hour)

4.1 Maintenance Program
4.2 Maintenance Checks and Inspection
4.3 Airworthiness Directives
4.4 Service Bulletins and Manufacturers Service Information
4.5 Modification and Repair
4.6 Maintenance Documents: Manuals
4.7 MMEL, DDL
4.8 Continuing Airworthiness- Test Flight
4.9 Category 2/3 Operation, All Weather Operation
4.10 ETOPS, Maintenance and Dispatch Requirements

Practical:

1. Write report on various topics on aviation legislation.
2. Create short report and presentation on understanding of aviation legislation issues.

References:

1) Nepal Civil Aviation Regulation
2) EASA Part M, Part 145, Part 21, Part 66
3) ICAO Annex 1-19
4) IATA
5) NCAR Part 66, 145,147
6) FAA Airworthiness Directives
7) Transport Canada
8) Bombardier Service Manual
9) Boeing Online Technical Publications

Evaluation Scheme:

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Unit	Chapter	Topics	Marks
1	1	1.1 - 1.2	16
2	2	All	16
3	3	All	16
4	4	4.1 - 4.7	16
5	1 & 4	1.3 & 4.8 - 4.10	16
Total			80