SANJAY GHODAWAT UNIVERSITY KOLHAPUR

Sanjay Ghodawat University (SGU) is established in the Academic Year 2017-18, as a State Private University under Govt. of Maharashtra Act No. XL of 2017 dated 3rd May 2017, with the approval of the UGC and the state Government. "For the true measure of giving is giving without measure." Spread across 150 Acres, Sou. Sushila Danchand Ghodawat Charitable Trust's Sanjay Ghodawat University (SGU) is situated in serene atmosphere amidst idyllic hills and lush green meadows to study in harmony with Nature. The Institution aspires to run along the lines of best-in- the-world education and become a world-class institution where teaching-learning process gets a far deeper meaning. SGU always stands as the guiding star of brilliance, quality and deliverance beyond expectations. Innovativeness and Creativity are the hallmarks of a genius enterprise and SGU stands to be a stage where these qualities would be nurtured, encouraged and blossomed. The genius is incomplete without the sense of social responsibility and SGU's ultimate goal remains the development of an attitude of gratitude that freely gives back without expectations.

The Sanjay Ghodawat University stands as a beacon of light to guide the younger generation of the day on the right path to fulfilment in career and life. The USP of the University is its research based curriculum and academically oriented teaching staff. The world class ambience and infrastructure helps the students to easily accommodate themselves in an environment that is conducive to the teaching- learning process. Hands on experience, challenge based case studies, maximum participation of students in the classroom, use of modern digital technology, smart classrooms, solution oriented thinking promotion, stress on research and innovation, international tie ups, choice based credit system for flexibility in choosing areas of interest etc. are some of the features of the University.

The university will help students develop as a unique individual-to be educated as a whole person, intellectually, emotionally, socially, ethically, and spiritually. The educational program designs are worked out meticulously in line with best in class universities with special focus on:

- Flexible Choice Based Credit System
- OBE - Outcome Based Education System
- Experiential Learning
- Project Based Learning

- Case Based Learning
- Training need analysis based on Performance Appraisal System
- Active Learning tools for effective delivery
- Mentoring / Proctorship
- On line learning /Self learning platforms
- Flipped Classroom concept
- Effective Student Feedback Mechanism

VISION

Internationally recognized university of excellence in creating and disseminating knowledge through value-based quality education leading to betterment of mankind.

MISSION

- To prepare students for life-long learning and leadership in a global academic culture
- To create intellectual manpower relevant to the industry and society at large
- To collaborate with institutions of international repute for academic excellence
- To promote research and development through conducive environment
- To encourage entrepreneurship and skill development programs

CORE VALUES

- Integrity
- Transparency
- Accountability
- Equality
- Empathy
- Stewardship

QUALITY POLICY

Sanjay Ghodawat University is committed to establish high standards in value-based quality education to enhance and nurture young minds to excel in their chosen profession and develop into socially responsible citizens through resourceful collaboration, innovation and research

CHOICE BASED CREDIT SYSTEM (CBCS)

The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.

University Grants Commission has come up with the Choice Based Credit System (CBCS) programme in which the students have a choice to choose from the prescribed courses, which are referred as core, elective or minor or soft skill courses and they can learn at their own pace and the entire assessment is graded-based on a credit system. The basic idea is to look into the needs of the students so as to keep up-to-date with development of higher education in India and abroad. CBCS aims to redefine the curriculum keeping pace with the liberalization and globalization in education. CBCS allows students an easy mode of mobility to various educational institutions spread across the world along with the facility of transfer of credits earned by students.

Where the students can choose the prescribed courses, as the core, and elective or soft skill courses, from a range of options, rather than to simply consume what the curriculum offers. They can learn at their own pace and the assessments are graded based on a credit system. It provides an opportunity for students to have a choice of courses or subjects within a programmed resembling a buffet, against the mostly fixed set of subjects now being offered (except for the limited choice of electives in professional degrees and postgraduate programmers) with the flexibility to complete the programmed by earning the required number of credits at a pace decided by the students.

The UGC has always initiated measures to bring efficiency and excellence in the Higher Education System of India. The basic motive is to expand academic quality in all aspects, right from the curriculum to the learning-teaching process to examination and evaluation systems. However, so far multiple methods are followed by different universities across the country towards examination, evaluation and grading system. Considering this diversity, the implementation of the choice based credit system seems to be a good system in assessing the overall performance of a student in a universal way of a single grading system.

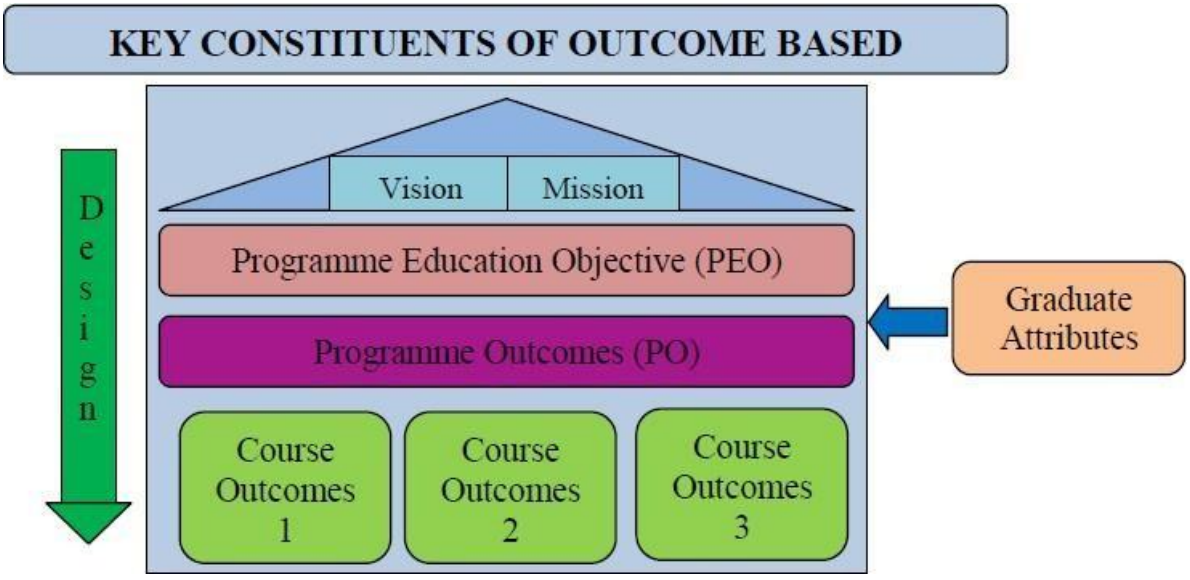
OUTCOME BASED EDUCATION (OBE) MODEL

Sanjay Ghodawat University (SGU) has implemented OBE model of education, which is a learner centered approach. SGU has witnessed a sea change in the entire academic systems with implementation of all three components of OBE – Design, Delivery and Assessment. The SGU model of autonomy focuses on experiential learning which believes in learning by doing. This is achieved through hands on experience, industrial assignments, mini projects and live problem solving and collaboration with industries.

SGU is set in to dynamics of transformation and witnessing a shift in focus from teaching to learning and entire academic system of SGU is designed to provide multiple learning opportunities for students to acquire and demonstrate the Knowledge, Skills and Attitudes (KSA) for rewarding career.

The Vision and Mission of the Management, contribution from eminent BOG members and knowledgeable members of Academic Council and Board of Studies, the motivation and drive of the Director, the relentless efforts of the fellow Deans and Head of Departments and all teaching and non teaching staff along with commitment to learning of students made it possible to successfully transform the institute and stand out to carve a niche for itself as an Institute of repute.

OBE is an approach of curriculum design and teaching that focuses on what students should be able to do (attained) at the end of course/ program. Outcome based education (OBE) is student-centered instruction model that focuses on measuring student performance through outcomes. Outcomes include knowledge, skills and attitudes (KSA). Its focus remains on evaluation of outcomes of the program by stating the knowledge, skill and behavior a graduate is expected to attain upon completion of a program and after 4 – 5 years of graduation. In the OBE model, the required knowledge and skill sets for a particular degree is predetermined and the students are evaluated for all the required parameters (Outcomes) during the course of the program.

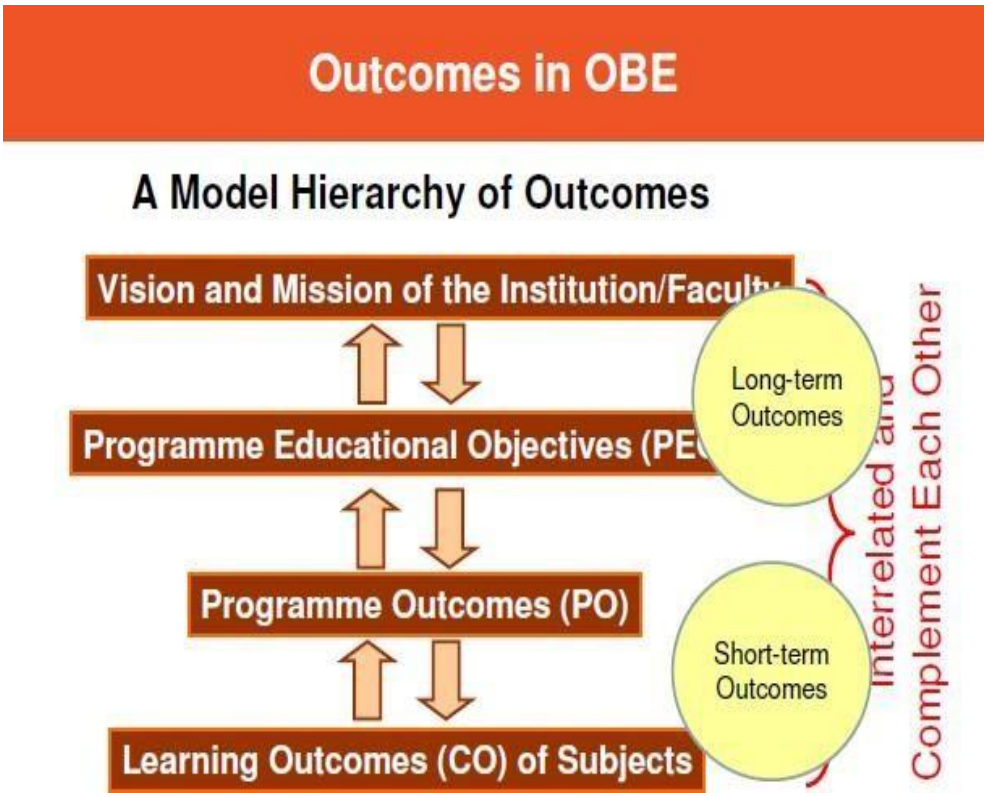


The OBE model measures the progress of the graduate in three parameters, which are

- Program Educational Objectives (PEO)
- Program Outcomes (PO)
- Course Outcomes (CO)

Program Educational Objectives (PEO) are broad statements that describe the career and professional accomplishments that the program is preparing the graduates to achieve. PEO's are measured 4-5 years after graduation. Program outcomes are narrower statements that describe what students are expected to know and be able to do by the time of graduation. They must reflect the Graduate attributes. Course outcomes are the measurable parameters which evaluates each students performance for each course that the student undertakes in every semester.

The various assessment tools for measuring the Course Outcomes include Tests and End Semester Examinations, Tutorials, Assignments, Project work, labs, Presentations, Employer or Alumni Feedback etc. These course outcomes are mapped to Graduate attributes and Program outcomes based on relevance. This evaluation pattern helps Institutions to measure the Program Outcome. The Program Educational Objective is measure through Employer satisfaction survey (Yearly), Alumni survey (Yearly), Placement records and higher education records.



Special Features of OBE

- OBE is an educational process that focuses on what students **can do** or the **qualities** they should develop after they are taught.
- OBE involves the restructuring of curriculum, assessment and reporting practices in education to reflect the achievement of high order learning and mastery rather than accumulation of course credits.
- Both structures and curricula are designed to achieve those **capabilities** or **qualities**.
- Discourages traditional education approaches based on direct instruction of facts and standard methods.
- It requires that the students demonstrate that they have learnt the required skills and content.

Sanjay Ghodawat University Kolhapur

(Established as a State University under Government of Maharashtra Act No XL dated 3rd May 2017)

Academic and Examination Rules and Regulations

Approved in the second Academic Council Meeting held on 9th May, 2018 and to be implemented from academic year 2018-19. [Version R0]

Sanjay Ghodawat University Kolhapur

Kolhapur - Sangli Highway, A/p Atigre - 416 118,
Tal. - Hatkanangale, Dist. Kolhapur,
Maharashtra, India

(Implemented from Academic year 2018-19)

Academic and Examination Rules and Regulations

Preamble

The Sanjay Ghodawat University (SGU) stands for quality and excellence. It aims at nurturing the young talent and grooming them into responsible citizen and a value added human resource. Outcome Based Education (OBE) model is adopted to enhance the effectiveness of teaching learning process and Credit Based semester system is implemented.

The focus of the University is its research based curriculum and academically oriented teaching staff. The world class ambience and infrastructure helps the students to easily accommodate themselves in an environment that is conducive to the teaching- learning process. Hands on experience, challenge based case studies, maximum participation of students in the classroom, use of modern digital technology, smart classrooms, solution oriented thinking promotion, stress on research and innovation, international tie ups, choice based credit system for flexibility in choosing areas of interest etc. are some of the features of the University.

Vision of SGU is internationally recognized university of excellence in creating and disseminating knowledge through value-based quality education leading to betterment of mankind. To achieve the vision SGU has developed state-of-the-art infrastructure that promotes conducive ambience promoting innovation and research. Create intellectual manpower relevant to the industry and society at large. Foster mutually beneficial partnership with alumni, industry and academia. Inculcate ethics and values to develop socially responsible citizens and promote entrepreneurship.

SGU is offering various programs through schools such as School of Technology, School of Commerce and Management, School of Sciences and School of Arts.

SGU has implemented the outcome-based Education (OBE) system and Credit based Evaluation System in all the schools.

The rules and regulations mentioned in this document are applicable to all the Under Graduate (UG) and Post Graduate programs offered by the Sanjay Ghodawat University from the academic year 2018-19. The rules and regulations stated under here are subject to revisions / refinements, updates and modifications and amendments by Academic Council (AC) from time to time and applicable to all batches including those already undergoing programs in different year and are binding on all stakeholders including students, faculty, parents and University authorities.

The academic programs of the University shall be governed by rules and regulations approved by the Academic Council from time to time. Academic council is the supreme and statutory academic body that governs all academic matters of the university and the decisions of the academic council are final and binding in the matters related to academics.

Definition of Terms

1. University: University means Sanjay Ghodawat University, Kolhapur
2. Academic Year: The period of the year during which students attend university for all academic activities, usually it starts from first of July and ends on 30th of June next year.
3. **Semester:** Academic Year is divided in to 2 parts called Semester, Odd Semester which starts from July and Even Semester which starts from January.
4. **Duration of Semester**: Total duration of semester is usually 20weeks per semester including instructions, examination and evaluation. Total instructional days are 90 per semester.
5. **Course:** It is a Subject that is in a semester. The course may consist of Theory/Practical/Project/Seminar during semester. Usually taught by instructor in a class. e.g. Physics, Chemistry, Engineering Mechanics, Workshop etc.
6. **Program:** Collection of Courses is called Program. B Tech in Mechanical Engineering,
7. M Tech in Civil Engineering, Bachelor of Business Administration. Bachelor of Science etc.
8. **Department:** Department is a unit of the school which offers one or more programs.
9. **Contact Hours:** Time of students in class/laboratory with instructor. Usually in the range of 26-30 Hrs./Week. For the purpose of uniformity one contact hour is measured as 60 minutes
10. **Academic Council (AC):** Means apex academic body governing the academic programs responsible for framing policy, rules and regulations.
11. **Board of Examination (BOE):** Central body responsible for framing policy ,rules and regulations for Examination.
12. **Board of Studies (BOS):** Departmental academic body to govern the academics of programs(BOS)offered by department.

3.0 Curriculum:

Curriculum:

Every program has a prescribed structure which, in general, is known as Curriculum. It prescribes courses to be studied in each semester. The booklet containing courses structure along with detail syllabus for each course of each

program is updated periodically and made available on the website.

Semesters:

SGU implements a credit based semester system. The academic year is divided into two regular semesters. The semesters that begin in July are known as Odd semester and the semester that begin in January are known as Even semesters. Total duration of each semester is generally of 20 weeks including the period of examination, evaluation and grade declaration.

Course Credit System/Structure:

In general, a certain quantum of work measured in terms of credits is laid down as the requirement for a particular program. Calculation of number of credits for a course in any semester is as per Table 3.1

Table 3.1: Calculation of number of credits for a course

Sr. No.	Course	Credits
1	Lecture of 1 hour/week	**1**
2	Tutorial of 1 hour/week	**1**
3	Practical / Laboratory / Drawing/mini-project of two hours/ week	**1**
4	Seminar (1 hour per week)	**1**

There are mainly two types of courses- viz. Theory courses and Laboratory courses. Generally a theory course consists of Lecture hours (L) and Tutorial hours (T). Tutorial hours may not be assigned to a particular theory course if it has a separate laboratory course. Laboratory course consists of practical hours (P) for which a student works in a Laboratory/Drawing Hall/Workshop. The other courses required to be taken by a student include seminar, mini project, and project at various levels of the program.

A student shall earn credits for a particular course by fulfilling the minimum academic requirements for attendance and evaluation. No credits shall be awarded if a student satisfies the minimum attendance requirements but fails to meet minimum evaluation requirements.

The total number of credits required for completing a program shall be mentioned in the course structure. The total number of credits in a semester which a student

registers shall generally be 20-25. The maximum number of credits per semester shall not exceed 30

Audit Course:

A student may have to register for an audit course in a semester which could be institute requirement or department requirement.

An audit course may include either a) a regular course required to be done as per structure or required as pre-requisite of any higher level course or b) the programmes like practical training, industry visits, societal activities etc.

Audit course shall not carry any credits but shall be reflected in Grade Card as "PP"/"NP" depending upon the satisfactory performance in the semester evaluation as per the course curriculum structure.

Course Registration:

Every student must register for the courses that he/she wants to study for earning credits at the beginning of each semester on the prescribed dates announced from time to time and shall be mandatory for every student till he/she completes the program. Only after registration his/her name shall appear in the roll list of each of such courses.

Students shall be required to fill up a Course Registration Form which shall be made available to them by the Student section of Administration office after payment of required fees.

Registration, according to rules, should be carried out as per the schedule given in academic calendar. Late registration may be permitted only for valid reasons and on payment of late registration fees. In any case, registration must be completed before the prescribed last date for registration, failing which his/her studentship shall be liable to be cancelled. Students having dues outstanding towards the institute or hostel shall be permitted to register only after clearing such dues.

In-absentia registration may be allowed only in rare cases at the discretion of the Dean Academics and with prior permission.

For registration in an odd semester, the student must have earned all the credits of the pre-previous year and at least 2/3rd credits of the previous year. For example, for registration of the 5^{th} semester courses (i.e. 3^{rd} year of program), a student must have earned all the credits of the first year and 2/3rd credits of the second year. Similarly, for registration of the 7^{th} semester courses (i.e. 4^{th} year of program), a student must have earned all the credits of the second year and 2/3rd credits of the third year. However, if 2/3rd calculation turns out to be a mixed number (integer + fraction) then only the integer part of that number shall be considered for taking decision related with this clause.

A student registered in odd semester shall be eligible to register for the courses offered in the even semester of that year irrespective of his/her SGPI or the number of credits earned by him/her in that odd semester.

Lateral Entry For B.Tech Programs

Post diploma students in engineering and B.Sc. Graduates can have lateral entry at third semester of the program. Such admissions are governed by the rules of regulatory bodies like AICTE New Delhi and Directorate of Technical Education Maharashtra state and Sanjay Ghodawat University for Admission criteria and shall undergo all academic requirements as specified by the Academic council.

For such students there shall not be First Year Performance Index (FYPI). Semester Performance Index (SGPI) and Cumulative Performance Index (CGPI) shall be calculated from the third semester onwards taking into consideration the courses undergone by them at Sanjay Ghodawat University Kolhapur.
Registration of the students not covered by the cases mentioned above shall be decided by the Academic Council. Such students shall undergo the academic program as specified by the Academic Council. Such odd entry students shall not be eligible for any medals or awards instituted by the institute.

Change of Program:

This is applicable to B Tech Program only. Students shall be eligible to apply for Change of Program after completing the first two semesters. The following rules/ guidelines shall be used for considering their applications for change:

The change of program shall be permitted strictly on merit basis subject to the rules of admissions prevailing at the time of such change.

Students without fail grades and/or backlogs shall be eligible to apply for change of program and can give their choices in the order of preference.

The request for change of program by a student from program A to program B shall be considered if number of students of program B does not exceed the sanctioned capacity of program B and also the minimum strength required to run the program as decided by Academic Council.

All such transfers can be effected only once at the beginning of the second academic year of the 4-year UG program. No application for change of program during subsequent academic years shall be entertained.

Facilitation to Students:

Faculty Advisor:

On joining the institute, a student or a group of students shall be assigned to a faculty advisor who shall be mentor for a student throughout his/her tenure in the institute. A student shall be expected to consult the faculty advisor on any matter relating to his/her academic performance and the courses he/she may take in various semesters / summer term. A Faculty advisor shall be the person to whom the parents/guardians should contact for performance related issues of their ward. The role of a faculty advisor is as outlined below:

The role of the Faculty Adviser is outlined below:

a. Guide the students about the rules and regulations governing the courses of study for a particular degree.
b. Advise the students for registering courses as per curriculum given. For this purpose the Faculty Adviser has to discuss with the student his/her academic performance during the previous semester and then decide the number and nature of the courses for which s/he can register during the semester as per the curriculum.
c. Approve the registration of the students.
d. Advice students to overload/ drop one or more courses/activities based on her/his academic performance as per the prescribed rules.
e. At the end of the first semester/year, the Faculty Adviser may even advise a reduced load program for a poorly performing student.
f. Pay special attention to weak students and carefully monitor performance of students recommended for slow track option.
g. Advice students for Course Adjustment / Dropping of courses during the Semester within the stipulated time frame given in the Academic calendar.
h. Advice students seeking semester drop either during the ongoing semester or before the commencement of the semester. FA has to ensure strict compliance of rules and regulations laid down for this purpose. Recommend the cases to the appropriate authorities for consideration.
i. Make revised plan of study for weak/bright students based on their semester wise performance.
j. Suggest modalities for course/credit requirements for the students recommended for exchange program.
k. Guidance and liaison with parents of students for their performance.
l. To ensure that students are not permitted to re•register for courses, which they have already passed.
m. Inform students that any academic activity (course / Lab. / seminar / project / noncredit requirement etc.) undergone without proper registration will not be counted towards the requirements of his/her degree.
n. Strictly warn students that if she/he fails to register during any semester without prior approval, his/her studentship is liable to be cancelled.

- Keep the students updated about the Academic Administration of the University.

7.2. Helping Weaker Students:

A student with backlog/s should continuously seek help from his/her faculty advisor, Head of the Department and the Dean of respective schools. Additionally, he/she must also be in constant touch with his/her parents/local guardians for keeping them informed about academic performance. The university also shall communicate to the parents/guardians of such student at least once during each semester regarding his/her performance in in-in various tests and examination and also about his/her attendance. It shall be expected that the parents/guardians too keep constant touch with the concerned faculty advisor or Head of the Department, and if necessary - the Dean of the respective school.

Discipline and Conduct:

Every student shall be required to observe discipline and decorous behavior both inside and outside the campus and not to indulge in any activity, which shall tend to bring down the prestige of the university.

Any act of indiscipline of a student reported to the Dean, Student Development, shall be discussed in a Disciplinary Action Committee of the institute. The Committee shall enquire into the charges and recommend suitable punishment if the charges are substantiated.

If a student while studying in the university is found indulging in anti-national activities contrary to the provisions of acts and laws enforced by Government he/she shall be liable to be expelled from the institute without any notice.

If a student is involved in any kind of ragging, the student shall be liable for strict action as per provisions in the Maharashtra anti-ragging act.

If any statement/information supplied by the student in connection with his/her admission is found to be false/ incorrect at any time, his/ her admission shall be cancelled and he/she shall be expelled from the university and fees paid shall be forfeited.

If a student is found guilty of malpractice in examinations then he/she shall be punished as per the recommendations of the Grievance Redressed Committee (CRC) constituted by Board of Examinations.

Every admitted student shall be issued photo identification (ID) card which must be retained by the student while he/she is registered at Sanjay Ghodawat University Kolhapur. The student must have valid ID card with him/her while in the University Campus.

Any student who alters or intentionally mutilates an ID card or who uses the ID card of another student or allows his/her ID card to be used by another, student shall be subjected to disciplinary action.

The valid ID card must be presented for identification purpose as and when demanded by authorities. Any student refusing to provide an ID card shall be subjected to disciplinary action.

Students should switch off the Mobiles during the Instructional hours and in the academic areas of university Building, Library, Reading room etc. Strict action will be taken if students do not adhere to this.

During the conduct of any Tests and Examination students must not bring their mobiles. A student in possession of the mobile whether in use or switched off condition will face disciplinary action and will be debarred from appearing for the Test / Examination.

9.0 Academic Calendar

The academic activities of the institute are regulated by Academic Calendar and is made available to the students/ faculty members and all other concerned in electronic form or hard copy. It shall be mandatory for students / faculty to strictly adhere to the academic calendar for completion of academic activities

Attendance:

Regular 100% attendance is expected from all students for every registered course in lectures, tutorial, laboratory, projects, mini-projects and other courses mentioned in program curriculum. Hence, attendance is compulsory and shall be monitored during the semester rigorously. Students shall be informed at the end of every month if they are failing short of attendance requirements.

A Maximum of 25% absence for the attendance may be permitted only on valid grounds such as illness, death in family of blood relations (Father, Mother, Sister, and Brother) and any other emergency reason which is beyond the control of the student and shall be approved by the authorities in respective departments.

If a student fails to put up 75% attendance individually in each course, the student will be put under X grade category and student will be debarred form attending the End Semester Examination (ESE) and Re-Exam for that semester in that course. However, student has an option to re-register for the course whenever it is offered next time or he can appear for 100% examination for which he will be awarded two grade penalties. Student's FET, CAT1 and CAT2 marks are treated as null and void.

The maximum number of days of absence for students participating in Co-curricular activities /Sports/ Cultural events during a semester shall not exceed 10. Any waiver in this context shall be on the approval of the Academic council only after the recommendation by Dean Academics of the university

The HOD and Dean of the respective school shall report and recommend to Academic council the cases of students not having 75% attendance as per the records of course instructor. After rigorously analyzing these cases AC may take a decision to debar such

student from End-Semester Examination (ESE) for that course. Such a student shall re-register for that course as and when it is offered next. ISE and MSE evaluations of such a student for this course during regular semester shall be treated as null & void.

A student remaining absent during ESE of a course either on medical ground (Accident and/or hospitalization of a student) or any other emergency circumstances (death of immediate close relative i.e. father, mother, brother and sister) or due to representing University at university/state level in sports/co-curricular activities shall be treated as per the rules of Sec 12.6.2 and 11.1.2

The critical cases of absenteeism which are not covered by any of the above clauses shall be reported by concerned Head of Department to Academic dean and all such cases the decision of Academic council is final.

Modes of Assessment:

Assessment of Theory Courses:

A student shall be evaluated for his/her academic performance in a theory course through Faculty Evaluation Theory (FET), Continuous Assessment Tests (CAT1 and CAT2) and End Semester Examination (ESE).

The relative weightage for the theory courses having ESE shall be generally as shown in the Table 11.1.2

Table 11.1.2: Weightage for the theory courses in %

FET	CAT1	CAT2	ESE
20	15	15	50

The details of the weightage of each course shall be listed in the structures of each program.

FET shall be based on student's performance in assignments, quizzes, seminars, Course projects and field assignments, term papers, etc. The mode of FET shall be decided and announced by the Course Instructor at the beginning of the course.

CAT1 shall generally be of one hour duration for each course and shall be held as per the schedule declared in the Academic calendar for that Semester. The test will be based on first two units of the course.

CAT2 shall generally be of one hour duration for each course and shall be held as per the schedule declared in the Academic calendar for that semester based on unit 3 and unit 4 of the syllabus.

ESE is of three hours comprehensive examination having the weightage of 60% for unit 5 and 6 and 40% to unit 1 to unit 4. It is of 100 marks

All examinations and evaluations shall be compulsory. Credits for a course shall be awarded only if a student satisfies evaluation criteria and acquires the necessary minimum grade.

There shall be no re-examination for CAT1 and CAT2 of the courses having all the three components of evaluation viz. FET, CAT1 CAT2 and ESE. However, a student remaining absent for CAT1 and CAT2 for representing the institute in state level or university level sports/co-curricular activities (on prior recommendation and approval from) or on valid grounds such as illness, death in family or other emergency reason which is beyond control of a student (on approval by the head of department and dean of respective school shall be considered for Make- up examinations.

A student remaining absent for ESE of a course either due to medical reason (Accident and/or hospitalization of a student) or other emergency circumstances (death of immediate close relative i.e. father, mother, brother and sister) or due to representing college at university/state level in sports/co-curricular activities shall be awarded with grade "I". Such a student shall be allowed to appear for make-up examination scheduled along with re-examinations of other courses. The student shall apply to COE with proper documentary evidence to appear for make-up examination. After make-up examination, a student shall be entitled to an appropriate grade as per Table I of Sec. 10.1.2 based on his/her performance during the regular semester and in make-up examination.

Assessment of Laboratory Courses:

The assessment of laboratory course shall be continuous and based on turn-by-turn supervision of the student's work and the quality of his/her work as prescribed through laboratory journals and his/her performance in viva-voce examinations uniformly distributed throughout the semester. Where ESE for the laboratory course is specified ESE shall be based on performing an experiment followed by an oral examination. The relative weightage for FEP and ESE for assessment of laboratory courses shall be 50% each for FEP and ESE and a minimum performance of 40% in both ISE and ESE separately shall be required to get the passing grade.

ESE for laboratory course shall normally be held before the ESE for theory courses and shall be conducted by a panel of examiners appointed by COE from the panel of

experts approved by BOS. This activity shall be coordinated by Department Examination Coordinator (DEC) in consultation with HOD of the respective department.

Student failed in ESE of a laboratory course in a regular semester shall be eligible to appear for 100% examination conducted alongwith ESEs of laboratory courses of the subsequent semester. Such examination shall be fairly comprehensive (generally of 3 hours similar to POE i.e. Practical-Oral-Examinations) to properly judge his/her practical skill and theoretical knowledge for that laboratory course. He/She shall suffer one grade penalty.

12.0 The Grading System:

Absolute Grading System (AGS) is adopted based on absolute numerical marks obtained by the student during all stages of evaluation for a course.

Award of Grade (Regular Semester):

For every course registered by a student in a semester, he/she shall be assigned a grade based on his/her combined performance in all components of evaluation scheme of a course as per the structure. The grade indicates an assessment of the student's performance and shall be associated with equivalent number called a grade point.

The academic performance of a student shall be graded on a ten point scale. The Absolute Grading System is followed. Letter grades, the guidelines for conversion of marks to letter grades and their equivalent grade points are as given in Table

Table 12.1.2: Grade Table for Regular Semester

Marks Obtained	Grade Letter GL	Grade Point GP	Performance Description
90-100	**O**	**10**	Outstanding
80-89	**A+**	**09**	Excellent
70-79	**A**	**08**	Very Good
60-69	**B+**	**07**	Good
50-59	**B**	**06**	Above Average

45-49	**C**	**05**	Average
40-44	**P**	**04**	Pass
00-39	**F**	**00**	Fail
-	**Ab**	**00**	Absent
-	**X**	**00**	Detained (Failed)
-	**Satisfactory**	-	Pass in Non Credit Courses
-	**Un Satisfactory**	-	Failed in Non Credit Courses

A student shall pass the course if he/she gets any grade in the range "O" to "P".

"FF" grade shall be awarded to a student in a course if he/she gets less 40% jointly in the FET, CAT1, and CAT2 & ESE for a theory course and in PET & ESE for a laboratory course. A course shall then be eligible to apply for re-examination. A student failed in laboratory course shall be eligible to apply only for 100% examination conducted with the laboratory examinations of the subsequent semester. In both cases, a student has to suffer one grade penalty.

13 Assignment of X Grade

Grade "X" in a regular course shall be given to a student if he/she falls in any of the following categories.

A student does not maintain the minimum 75% attendance in any of the theory or laboratory courses.

A student has not completed most of the Evaluations like FET, CAT1 and CAT2 due to non-medical reasons (for example when a student has missed all or most of the components of internal evaluation conducted by the instructor in that semester).

The performance of a student is less than 40% in FET, CAT1 and CAT2 Combined.

A student is guilty of any academic malpractice during semester (Such cases shall be dealt by Grievance Redressed and Discipline Committee).

In above four cases grade "X" shall be declared one week before ESE and intimated to the Academic Office and COE immediately thereafter. Such a student shall not be permitted to take the ESE of that course.

Grade "X" may be given to a student if

13.1..5.1 A student eligible for ESE remains absent for ESE of a course with no written intimation to Exam Cell within four days after the respective ESE is over.

13.1.5.2 A student is guilty of any academic malpractice during examination. (Such cases shall be dealt by Grievance Redressal Committee).

In 13.1.5.2 grade "X" in that course shall be declared after Grievance Redressed Committee confirms the academic malpractice.

In above two cases when a student gets "X " grade in a course, then this shall be treated as "FF" for the purpose of calculation of Semester Performance Index (SGPI) and First Year Performance Index (FYPI) or Cumulative Performance Index (CGPI).

Following rules apply to the student who has obtained grade "X" in a regular semester:

A student obtaining grade "X" in a course in a regular semester or during examination shall be not be allowed to appear for End semester examination and also Re ESE conducted before the beginning of the next semester. His/her FET, CAT1 and CAT2 evaluations for all courses shall be treated as null and void. He/She needs to re-register for courses of that semester in the next academic year whenever they are offered and undergo all evaluations along with fresh regular students for which he will get one grade penalty.

Grade "I" shall be declared in a theory/laboratory course if a student has satisfactory performance FET, CAT1, CAT2 and has fulfilled the 75% attendance requirement, but has not appeared for ESE due to genuine reasons. Such students shall be eligible for the make-up examination of ESE only on medical grounds/valid reasons and on production of authentic medical certificate or other supporting document/s (as required by the University) to the COE within ten days after the respective examination is over. The application form with requisite amount of fees must be submitted to the Exam Cell before the last date of filling such application forms for make-up examinations. These examinations shall be based on 100% syllabus and shall be scheduled before the commencement of the subsequent semester for theory courses and along with ESEs of laboratory courses of the subsequent semester. A student with "I" grade when appears for the make-up examination shall be eligible to obtain a regular performance grade ("O" to "F") as per Table 11.1.2 depending on his/her overall performance in FET, CAT1 ,CAT2 and make-up examination. If a student fails to appear for make-up examination too, a grade "XX" shall be awarded to him/her. Thus "I" is only a temporary grade and shall be replaced by a valid grade only after make-up examination.

There shall be a few audit courses as per the policies of the institute or as decided by DPC of respective program. The grade "PP" (Passed)/ "NP" (Not Passed) shall be awarded for such courses depending upon the performance of a student evaluated by the faculty in-charge. No grade points shall be associated with these grades and performance in these courses shall be not taken into account in the calculation of the performance indices (SGPI, CGPI). However, the award of the degree shall be subject to obtaining a "PP" grade in all such courses.

Award of Grades for Re-Examination:

A student who has obtained grade "F" in regular semester shall be eligible to appear for re-examination conducted before the commencement of the next regular semester. In such cases FET, CAT1 and CAT2 marks are carried forward and a student has to suffer one grade penalty

A student shall apply for re-examination before the last date of such application and shall appear for re-examination.

50% weightage similar to ESE shall be given to re-examination and there is one grade penalty.

A student who has obtained "F" grade in ESE of a regular semester and has not availed re-examination option or a student who has obtained "F" grade in both ESE and re- examination shall be eligible to choose one of the two options below to clear his/her backlog:

- Re-registration for the next regular semester course whenever that course is offered.
- Appearing for ESE of the course when conducted...
  A student detained in a regular semester due to either a) by obtaining "X" grade or b) by involvement in academic malpractice or c) by breaking the institute code of conduct and discipline can re-register for the course when offered next

Following rules apply for these cases:

In first case i.e. Re- registration the earlier performance of a student in all the evaluations of that course shall be treated as null and void. The student has to undergo all the evaluations after re-registration.

Grades for Third and Subsequent attempts:

If A student opts for ESE or Re ESE who previously had obtained grade "F" in a course in two attempts, his/her FET, CAT1 and CAT2 performance of the regular semester shall be considered for evaluation and he/she has to suffer two grade penalty for the third attempt and for 4th and subsequent attempts shall be awarded a grade "P" or "F" or "X" based on his/her performance.. However, if a student takes more than three chances (regular

examination being the first chance, re-examination being the second chance, to clear a course, then the maximum passing grade that he/she can get shall be only "P". Thus a student has to suffer a grade penalty by accepting a lower grade than that obtained in the regular examination, re-examination, or examination for a re-registered course.

14. CALCULATION OF PERFORMANCE INDICES:

Semester Grade Point Average (SGPA)

The performance of a student in a one specific semester is indicated by SGPA. SGPA is a weighted average of the grade points obtained in all courses registered by the students during the semester. SGPA can be calculated by following equation.

$$SGPA \; S_i = \frac{\sum_{i=1}^{n} C_i P_i}{\sum_{i=1}^{n} C_i}$$

Where, i = 1,2,3…….n are number of courses during semesters. C = No of credits associated with that course and P = Grade point earned in that course. SGPA will be rounded off to two decimal places.

Cumulative Grade Point Average (CGPA)

The total cumulative performance of a student at the end of specific semester is indicated by CGPA. An up-to-date assessment of the overall performance of a student for the courses from the first semester onwards till completion of the program shall be obtained by calculating Cumulative Grade Point Average (CGPA).

CGPA is a weighted average of the SGPA obtained in all semesters by the students during the semesters. CGPA can be calculated by following equation.

$$CGPA = \frac{\sum_{j=1}^{n} C_j S_j}{\sum_{j=1}^{n} C_i}$$

Where, j = 1,2,3…….n are number of semester during program. C = Total No of credits in the semester for which CGPA is to be calculated.

CGPA will be rounded off to two decimal places.

Conversion of CGPA to percentage marks for CGPA ≥ 4.5 can be obtained using equations. Percentage marks = (CGPA x 10) – 7.5.

For the students acquiring "I" grade (which is only a temporary grade) in any of the courses, SGPA, CGPA shall be calculated only after make-up examination.

14.4. First Year Performance Index (FYPI): (Applicable For B. Tech Programs Only)

For a student registered in Sanjay Ghodawat University Kolhapur right from the First semester, First-Year-Performance-Index (FYPI) shall be calculated as weighted average of the grade points obtained in all the courses registered by him/her in semesters I and II only.

$$FYPI = \frac{\sum_{1} C_i g_i}{\sum_{1} C_i}$$

Where summation is for all the courses registered by a student in first two semesters. FYPI shall be calculated when SPI for the second semester is calculated. FYPI shall be rounded off to two decimal places.

FYPI shall reflect all the courses undergone by a student in the first year including the courses in which he/she has failed. FYPI may get modified in the subsequent semesters whenever a student clears his/her first year backlog courses.

If a student has been awarded "I" grade in the regular semester course of the first year then, FYPI shall be calculated after the make-up examination on the basis of the grade obtained by that student in a make-up examination.

If a student has obtained grade "F" or "X" at any time in any of the courses registered by him, then zero grade points corresponding to these grades shall be taken into consideration for calculation of FYPI.

15 Maximum Duration for Completing the Program

Maximum duration for completing any program UG/PG offered by Sanjay Ghodawat University is respective program duration plus two additional years.

Maximum duration for getting the B. Tech degree for students admitted in the first semester of UG program is, program duration plus two additional years (i.e. 12 Semesters and 6 academic years) For lateral entry student academic admitted in the third semester shall be (10 Semester and 5 Years).

The maximum duration of the program includes the period of withdrawal, absence and different kind of leaves permission to student but excludes the period of rustication of the student from the university however genuine case an confidential of valid reason may be referred to academic council for extending this limit by additional criteria

16 NFTE (Not Fit For Technical Education) (Applicable to B Tech program only)

It is mandatory for the student to earn all credits of first year specified for semester I & II or eligible for ATKT as per the rules to seek admission to semester III of second year in three years from the date of admission to avoid NFTE. If a student fails to become eligible for admission to Semester III in three year form the date of his admission, he shall be declared as "Not Fit for Technical Education" leading to discontinuation of his/her registration with the university. Such cases should be put up in the academic council.

17. Academic Progress Rules (ATKT Rules):

17.1 A student shall be allowed to register for the courses of the next year's odd semester only if he/she has earned all the credits of the previous year and has earned at least 75% credits of the current year. If 75% calculation turns out to be a mixed number (integer + fraction) then only the integer part of that number shall be considered for deciding the eligibility for ATKT.

At the end of 1st year a student shall be allowed to keep terms (ATKT) to 2nd year of study provided he/she attends course work prescribed for 1st year with prescribed attendance and successfully earned at least 75% of the total credits specified for 1st year program.

For Example: Total credits for B. Tech first year 2017-18, are 45 (Total of Semester I and II). A Student should earn mininum75% of the 45 Credits i.e. 33.15 (Rounded to 33 Credits). A student can go to next higher class with a maximum backlog of 12 credits of semester I & II of the first year.

Student, who fails to earn those credits, cannot register for next semester, either it can re-registrar for the course and credits or can use the next opportunity to earn the credits when exams are conducted. .

(b) At the end of 2nd year a candidate shall be allowed to keep terms to 3rd year of study provided he/she attends course work prescribed for 2nd year with prescribed attendance, and successfully cleared 1st year program and at least 75% of total credits prescribed for 2nd year program.

(c) At the end of 3rd year a candidate shall be allowed to keep terms to final year of study provided he/she attendants course work prescribed for 3rd year with prescribed attendance, and should have completed 2nd year program and 75% of total credits prescribed for 3rd year program.

All such candidates fulfilling the above criteria shall be declared as FAILED, ATKT.

A student shall be allowed to take admission for odd semester of next academic year only if he/ she have earned all the credits of the previous year and 75% happens to be a decimal, it is rounded to only integer part.

18 Semester Grade Report:

Semester grade report reflects the performance of a student in that semester (SGPI) and also his/her cumulative performance for the first year (FYPI) and also the cumulative performance since the third semester of his/her study (CGPA).

The semester grade card issued at the end of each semester/ summer term to each student shall contain the following.

- The credits for each course registered for that semester.
- Any audit course/s undertaken by a student in a Semester.
- The letter grade obtained in each course.
- The total number of credits earned by a student for the first year separately.
- The total number of credits earned by a student since the 3rd semester onwards.
- SGPI, FYPI, CGPI.
- A list of backlog courses, if any.
- Remarks regarding eligibility of registration for the next semester.

Semester grade card shall not indicate class or division or rank however a conversion from grade point index to percentage based on CGPI shall be indicated on the final grade card of the program.

19 Award of Degree:

Following rules prevail for the award of degree.

- A student has registered and passed all the prescribed courses under the general institutional and departmental requirements.
- A student has obtained CGPI $\geq$ 4.75.
- A student has paid all the institute dues and satisfied all the requirements prescribed.

- A student has no case of indiscipline pending against him/her. Academic Council shall recommend the award of degree to a student who is declared to be eligible and qualified for above norms.

20.0 Grace Marks

- Maximum total grace marks will be 1% of the total theory credit courses x 100 subjected
- To maximum 6 marks in that semester.
- Grace marks will be given to candidate for change in grades for theory credit courses, i.e. from fail to pass grade only and will be reflected in final ESE marks.
- The grace marks are applicable only for maximum 1/3rd courses (rounded to higher Integer part i.e. if there are 4 theory courses then 4/3 = 1.33 = 2 courses).
- Maximum grace marks will be distributed in maximum courses
- Benefit of grace marks is not applicable for any medal/award.
- Applicable to theory and (Theory + Practical Courses). If is not applicable for Practical courses.
- Scheme for grace marks only can be used when the student will pass in all courses of That semester.

CGPA Improvement Policy for Award of Degree:

An opportunity shall be given to a student who has earned all the credits required by the respective program with CGPA greater than or equal to 4.00 but less than 4.75 to improve his/her grade by allowing him/her to appear for ESE examinations of maximum two theory courses of seventh semester. Such examinations shall be scheduled along with re-examinations/make-up examinations. However, CGPA shall be limited to 4.75 even though the performance of a student as calculated through modified CGPA becomes greater than 4.75.

Conclusions:

The academic policies regarding conduct of programs in Sanjay Ghodawat University Kolhapur are published in this document. The Academic Council shall reserve the right to modify these policies as and when required from the point of view of achieving academic excellence. In special and abnormal cases (i.e. the cases not covered through above rules) the decision of the (Chairman, Academic Council shall be final and shall be binding on all concerned.

Chairman
Academic Council

Curriculum Structure for Master of Technology (Aerospace Engineering)

Part-I AY 2024-25 (Batch 2024-25-26)

SEMESTER I

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS101	Finite Element Method	3	-	2	4	Theory & Practical	FA	50	50%	40%	40%
							SA	100	50%	40%	
PAS102	Rocket Propulsion	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	
PAS103	Aerospace Structure	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	
PAS104	Flight Performance	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	
PAS105	Advanced Aerodynamics	3	-	2	4	Theory & Practical	FA	50	50%	40%	40%
							SA	100	50%	40%	
PAS106	Domain Specific MOOC-I	-	-	2	-	Practical	FA	100	100%	40%	Satisfactory/ Non-Satisfactory
							SA	-	-	-	
	Total	***15***	***03***	***06***	***20***		***Total Hrs:24 Total Credit: 20***				

L: Lecture; T: Tutorial; P: Lab Practical; J: Project or activity based learning; FA: Formative Assessment (Theory and/or Practical); SA: Summative Assessment-End Semester Examination; PC: Program Core Course; PE: Program Elective; UC: University Core; NC: Non-Credit Course; UMNCC: University Mandatory Non- Credit Course, UE-University Elective, FA-Formative Assessment, SA-Summative Assessment

Curriculum Structure for Master of Technology (Aerospace Engineering)

Part-I AY 2024-25 (Batch 2024-25-26)

SEMESTER II

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PMC001	Research Methodology	2	-	4	4	Theory & Practical	FA	100	70%	40%	40%
							SA	50	30%	40%	
PAS202	Computational Fluid Dynamics	3	-	2	4	Theory & Practical	FA	50	50%	40%	40%
							SA	100	50%	40%	
PAS203	Hypersonic Aerodynamics	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	
PAS204	Satellite Technology	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	
PAS205	Program Elective -I	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	
PAS206	Domain Specific MOOC-II	-	-	2	-	Practical	FA	100	100%	40%	Satisfactory/ Non-Satisfactory
							SA	-	-	-	
	Total	***14***	***03***	***08***	***20***		***Total Hrs:25 Total Credit: 20***				

L: Lecture; T: Tutorial; P: Lab Practical; J: Project or activity based learning; FA: Formative Assessment (Theory and/or Practical); SA: Summative Assessment-End Semester Examination; PC: Program Core Course; PE: Program Elective; UC: University Core; NC: Non- Credit Course; UMNCC: University Mandatory Non- Credit Course, UE-University Elective, FA-Formative Assessment, SA-Summative Assessment

PROGRAM ELECTIVE

SEM	CODE		Subject Name
Program Elective - I			
II	**PAS205A**	Propellant Technology	
	PAS205B	Aerospace Navigation	

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS101	Finite Elements Method	3	-	2	4	Theory & Practical	FA	50	50%	40%	40%
							SA	100	50%	40%	

Course Outcomes: The students will be able to,

CO1 **Explain[2]** the basic principles and procedure of FEM

CO2 **Formulate[3]** simple engineering problems using FEM

CO3 **Analyze[4]** the complex engineering problems using FEM

CO4 **Evaluate[5]** axis symmetric problems related to higher order elements

CO5 **Analyze[4]** dynamic problem in different sections

Unit No.	Content	Hrs.
1	**FEM BASICS:** Need for sue of FEM – Advantages and Disadvantages of FEM Matrix algebra – Terminologies relating to matrices, methods of solution of linear algebraic equations. Eigen values and Eigen vectors, Simple numeric Gaussian Quadrature – 1 pt. 2pt and 3pt formula.	7
2	**CONTINUUM METHODS** Variational methods Rayleigh-Ritz methods applied to simple problems on axially loaded members cantilever. Simply supported and fixed beam with point loads and UDL Galerkin method as applied to simple elasticity problem.	7
3	**FEM-BASIC DEFINITIONS** Displacement method Nodal degrees of freedom different coordinate systems , shape functions. Lagrangian polynomial; complete Formulation of bar- truss- beam- triangular-quadrilateral Tetrahedral hexahedral elements.	7
4	**ISOPARAMETRIC ELEMENTS** Definition and use of different forms of 2-D and 3-D elements. - Formulation of element stiffness matrix and load vector. Solution for 2-D problems (static analysis and heat transfer) using software packages.	7
5	**HIGHER ORDER ELEMENTS** Bar–triangular quadrilateral elements. Tetrahedral and hexahedral elements (non-Formulation)–Pascal triangle – Pascal pyramid. Introduction to axis symmetric problems-formulation of axis symmetric triangular element.	7
6	**SOLUTION SCHEMES** Different methods of solution of simultaneous equations governing static, dynamics and stability problems. General purpose Software packages.	5

Text Books:

1. Introduction to Finite Elements in Engineering" by T R Chandrupatla and A D Belegundu, Pearson
2. Introduction to the Finite Element Method by J N Reddy,McGraw-Hill Education.
3. Daryl L.Logon, A First course in Finite Element Methods, Thomson Learning 3rd Edi. 2001
4. Hutton, Fundamentals of Finite Element Method, Mc Graw Hill, 2004.
5. Robert Cook, Concepts & Applications of FEA, etal – Jonhwilley& sons 2002

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS102	Rocket Propulsion	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	

Course Outcomes: After the completion of this course, the student will able to,

CO1 **Explain**[2] the fundamentals of rocket propulsion
CO2 **Apply**[3] the nozzle theory and thermodynamic relations to solve rocket propulsion problems
CO3 **Explain**[2] liquid and hybrid propulsion systems used in rockets
CO4 **Apply**[3] concepts of propulsion to solve solid propellant problems
CO5 **Explain**[2] advanced rocket propulsion systems and techniques

Unit No	Contents	Lecture Hrs
1	**FUNDAMENTALS OF ROCKET PROPULSION** Operating principle –Applications – Definitions and fundamental parameters: Thrust, Exhaust Velocity, Energy and Efficiencies, Typical Performance Values	6
2	**NOZZLE THEORY AND THERMODYNAMIC RELATIONS** Ideal rocket – Isentropic flow through nozzles – Nozzle Performance: nozzle area ratio, characteristic velocity, thrust coefficient – Nozzle configurations, Under-expansion and over-expansion	7
3	**LIQUID PROPULSION** Classifications –Propulsion system components and its functions - Propellant feed systems and Turbo pump feed system - injectors and types - Thrust chamber and its cooling - Cryogenic propulsion system, special features of cryogenic systems	7
4	**SOLID PROPULSION** Application and Classification of Solid Propellant Rocket Motors - Propellants and Characteristics - Ingredients and Processing - Propellant Burning Rate - Propellant Grains and Grain Configurations - Grain Design.	7
5	**HYBRID PROPULSION** Classification - System Arrangement and Components - Typical Fuels and Oxidizers - Advantages and Disadvantages - Application Areas - Performance and Limitations - Performance Parameters of selected existing Hybrid Rocket Engines - System Integration - Manufacturing Methods for Low and High- thrust Engines.	7
6	**ADVANCED PROPULSION TECHNIQUES** Electric rocket propulsion– types of electric propulsion techniques - Ion propulsion – Nuclear rocket – comparison of performance of these propulsion systems with chemical rocket propulsion systems – future applications of electric propulsion systems - Solar sail.	6

Text Books:
1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.
2. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988.

Reference Books:
1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley and Sons Inc., New York, 8th Edn., 2012.
2. Cornelisse, J.W., Rocket Propulsion and Spaceflight Dynamics, Pitman Publishing, 1979.
3. Hill, P.G. and Peterson, C.R. "Mechanics and Thermodynamics of Propulsion" Addison, Wesley Longman INC, 1999.

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS103	Aerospace Structure	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	

CO1 **Analyze[4]** various types of aircraft and spacecraft components based on its configurations.

CO2 **Analyze[4]** shear flow and shear center in thin wall sections.

CO3 **Explain[2]** structural instability in thin plates.

CO4 **Calculate[3]** bending, shear and torsion of thin walled beams.

CO5 **Describe[2]** smart materials and adaptive materials

Unit No	Contents	Lecture Hrs
1	**ANALYSIS OF STRUCTURAL COMPONENTS AND LOADS OF AIRCRAFT** Loads on Structural components, Function of structural components, Fabrication of structural components, Connections; Airworthiness: Factors of Safety- flight envelope, Load factor determination, Airframe loads: Aircraft inertia loads, Symmetric maneuver loads, Normal accelerations associated with various types of maneuvers, Gust loads.	6
2	**SHEAR FLOW AND SHEAR CENTER IN OPEN AND CLOSED THIN WALL SECTIONS:** Open Sections:Shear center and elastic axis, Concept of shear flow, Beams with one axis of symmetry; Closed Sections: Bradt-Batho formula, Single and multi-cell closed box structures, Semi monocoque and mono cocque structures, Shear flow in single and multi cell monocoque and semi monocoque box beams subject to torsion	6
3	**STRUCTURAL INSTABILITY IN THIN PLATES** Bending of thin plates having a small initial curvature, Energy method for bending of thin plates; Structural Instability in Thin Plates: Buckling of thin plates, Inelastic buckling of plates, Experimental determination of critical loads for a flat plate, Local instability, Instability of stiffened panels.	8
4	**BENDING, SHEAR AND TORSION OF THIN-WALLED BEAMS** Calculation of section properties, Applicability of bending theory, Temperature effects; Shear of Beams: General stress, strain and displacement relationships for open and single cell closed section thin-walled beams. Combined Open and Closed Section Beams: Bending, Shear, Torsion	6
5	**SMART MATERIALS** Smart Materials Technologies and Control Applications: Control requirements, Smart Materials-Piezoelectric elements, Electrostrictive elements, Magentostrictive transducers, Electrorheological fluids, Shape memory alloys.	8
6	**ADAPTIVE STRUCTURES** Fiber optic sensors, Applications of smart materials, Adaptive Structures: Adaptive aerospace structures-Structural Health Monitoring (SHM), Shape control and active flow, Damping of vibration and noise, Smart skins System.	6

Text Books:
1.Aircraft Structures for Engineering Students , Fourth Edition, T. H. G. Megson, Butterworth-Heinemann, Elsevier Ltd, 2007

Reference Books:
1.Airplane Structural Analysis and Design, Earnest E. Sechler, Lois G. Dunn, Dover Publications, 1963
2.Theory and Analysis of Flight Structures, Robert M. Rivello, McGraw-Hill, 1969
3.Mechanics of Aircraft Structures, Second Edition, C. T. Sun, John Wiley & Sons, 2006.

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS104	Flight Performance	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	

Course Outcomes: After the completion of this course, the student will able to,

CO1 **Apply**[3] the basic airplane performance parameters.

CO2 **Differentiate**[3] the aircraft performance in steady unaccelerated and accelerated flight.

CO3 **Explain**[2] the aircraft maneuver performance.

CO4 **Explain**[2] the aircraft takeoff and landing performance.

CO5 **Differentiate**[3] the aircraft pull up and pulldown maneuver

Unit No	Contents	Lecture Hrs
1	**THE EQUATIONS OF MOTION STEADY UN-ACCELERATED FLIGHT** Introduction, four forces of flight, General equation of motion, Power available and power required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.	6
2	**STEADY PERFORMANCE – LEVEL FLIGHT, CLIMB & GLIDE** Performance: Equation of motion for Rate of climb- graphical and analytical approach -Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach, climb performance graph (hodograph diagram); maximum climb angle and rate of climb Gliding flight, Range during glide, minimum rate of sink and shallowest angle of glide.	7
3	**FUNDAMENTAL AIRPLANE PERFORMANCE PARAMETERS** The fundamental Parameters: Thrust – to – weight ratio, Wing loading, Drag polar, and lift-to – drag ratio. Minimum velocity. Aerodynamic relations associated with lift-to-drag ratio.	6
4	**RANGE AND ENDURANCE** Propeller driven Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance. Jet Airplane: Physical consideration, Quantitative formulation, Equation for Range and Endurance, Conditions for maximum range and endurance, Effect of head wind tail wind.	7
5	**AIRCRAFT PERFORMANCE IN ACCELERATED FLIGHT** **Take-off Performance**: Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length **Landing Performance and Accelerated Climb:** Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in	7

6	**MANEUVER PERFORMANCE**	**7**

Turning performance: Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down maneuvers: (Turning rate, turn radius). Limiting case for large load factor. The V-n diagram. Limitations of pull up and push over.

Textbook/s

1 **John D. Anderson,** Aircraft Performance and Design, McGraw-Hill International, Aerospace Science/ Technology Editions, 1999

2 **John D. Anderson,**Introduction to flight, McGraw-Hill International, Aerospace Science/ Technology Editions, 2000

Reference Books

1 **Perkins, C.D., and Hage, R.E ,** Airplane Performance stability and Control John Wiley Son Inc, New York
1988

2 **Barnes W. McCormick ,** Aerodynamics, Aeronautics, and Flight Mechanics, John Wiley Son Inc, New York,1995

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS105	Advanced Aerodynamics	3	-	2	4	Theory & Practical	FA	50	50%	40%	40%
							SA	100	50%	40%	

Course Outcomes: After the completion of this course, the student will able to,

CO1 **Explain[2]** the fundamental knowledge of aerodynamics

CO2 **Explain[2]** incompressible flow and its applications

CO3 **Calculate[3]** the compressible flow properties over an flying vehicles

CO4 **Select[4]** the appropriate flow analysis method to study the component of flying vehicles

CO5 **Select[4]** the appropriate flow measurement devices

Unit No	Contents	Lecture Hrs
1	**INTRODUCTION TO AERODYNAMICS** Hot air balloon and aircrafts, Various types of airplanes, Wings and airfoils, lift and Drag, Centre of pressure and aerodynamic centre, Coefficient of pressure, moment coefficient, Continuity and Momentum equations, Point source and sink, doublet, Free and Forced Vortex, Uniform parallel flow, combination of basic flows, Pressure and Velocity distributions on bodies with and without circulation in ideal and real fluid flows, Magnus effect.	6
2	**INCOMPRESSIBLE FLOW THEORY** Conformal Transformation, Kutta condition, Karman – Trefftz profiles, Thin aerofoil Theory and its applications. Vortex line, Horse shoe vortex, Biot - Savart law, lifting line theory.	6
3	**COMPRESSIBLE FLOW THEORY** Compressibility, Isentropic flow through nozzles, shocks and expansion waves, Rayleigh and Fanno Flow, Potential equation for compressible flow, small perturbation theory, Prandtl- Glauert Rule, Linearised supersonic flow, Method of characteristics.	8
4	**AIRFOILS, WINGS AND AIRPLANE CONFIGURATION IN HIGH SPEED FLOWS** Critical Mach number, Drag divergence Mach number, Shock stall, supercritical airfoils, Transonic area rule, Swept wings (ASW and FSW), supersonic airfoils, wave drag, delta wings, Design considerations for supersonic airplanes.	6
5	**VISCOUS FLOW AND FLOW MEASUREMENTS** Basics of viscous flow theory – Boundary Layer – Displacement, momentum and Energy Thickness – Laminar and Turbulent boundary layers – Boundary layer over flat plate – Blasius Solution - Types of wind tunnels – Flow visualization techniques– Measurement of force and moments in wind tunnels.	8
6	**UAV Aerodynamics** UAV aerodynamics, structures and propulsion, performance and stability analysis.	6

Textbook/s

1 **J.D. Anderson,** "Fundamentals of Aerodynamics", McGraw-Hill Book Co., New York, 5th edition 2010
2 **Rathakrishnan.E**., Gas Dynamics, Prentice Hall of India, 5th edition, 2013.
3 **Shapiro, A.H.,** Dynamics & Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982.

Reference Books

1 **W.H. Rae and A. Pope,** "Low speed Wind Tunnel Testing", John Wiley Publications, 3rd Edition 1999
2 **Zucrow, M.J., and Anderson, J.D**., Elements of gas dynamics McGraw-Hill Book Co., New York, 1989

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PMC001	Research Methodology	2	-	2	4	Theory & Practical	FA	100	70%	40%	40%
							SA	50	30%	40%	

Course Outcomes: after the end of this course students will able to	
CO 1	Adapt to different kinds of research, identify literature relevant to the topic
CO 2	Identify the problem in the literature identified
CO 3	State the research problem clearly with the help of literature studied
CO 4	Prepare report based on the problem studied literature, problem identified

Course Contents

Unit	Description	Hours
I	**Research Fundamentals and Types** Definition and objectives of Research: Research method and research methodology, Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity and reliability of research. Objective of research. Types of Research: Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches Ethical Issues in research	06
II	**Research Process and Research Modelling:** Steps in research process Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample Design Relevance, interest, available data, choice of data, Analysis of data, Generalization and interpretation, Outcome of Research: Design of sample surveys Sampling design, measurement and scaling, data collection, data preparation and data analysis using various techniques Research outcomes Research papers and Publications	06
III	**Hypothesis Formulation and Testing:** Probability distributions. Type I and II error, testing of mean, proportion, tests for equality of mean and variances of two populations, confidence interval, Z test and $\chi 2$ test for goodness of fit, ANOVA (one-way classification), non-parametric tests: sign test, U test. Correlation and Regression Analysis: Karl Pearson's and Rank Correlation coefficient, simple linear regression: least squares method	06
IV	**Interpretation and Report Writing:** Meaning of interpretation, why interpretation?, technique of interpretation, precautions in interpretation, significance of report writing, different steps in writing report, layout of the research report, mechanics of writing a research report, precautions for writing research report	06

Laboratory Work

The laboratory work consists of extensive project which consists of following projects. It is mandatory for the student to turn in a report that is based on the work. Continuous evaluation of the project is going to be carried out

at regular intervals:

Project – 01: ***Search and identify relevant literature (20Marks)***
Students should be able to study the literature available. Student should be able to search and identify the relevant source and quality research papers required in the domain of selected area by themselves.
Project – 02: ***Survey the available literature(20 Marks)***
Student should be able to study the literature identified. Prepare one page summary of the papers identified by them. (At least 10 papers). Afterthese final papers which are relevant to the identified problem will be selected by the student.
Project – 03: ***Critically appraise the literature identified (20 Marks)***
All available literature including relevant theories, reports, records, and other relevant literature on the problem needs to be reviewed and examined. This would help the student to identify the data available, the techniques that might be used, types of difficulties that may be encountered during the study, possible analytical shortcomings, and even new methods of approach to the present problem
Project – 04: ***Go for discussions for developing ideas(20 marks)***
The student may discuss the problem with his/her colleagues along with research supervisor and others related to the concerned subject. This helps the student to generate new ideas, identify different aspects on the problem, gain suggestions and advices from others, and sharpen his focus on certain aspects within the field.
Project – 05: ***Prepare a report based on the findings of the above study (20 Marks)***
Finally, the student must rephrase the problem into a working proposition. The student should be able to prepare a report based on outcomes of the above four projects.

Scheme of evaluation

Formative assessment				
SN	**Component**	**Marks**	**Weightage**	**Total**
1	Project 1: ***Search and identify relevant literature***	20	10	50
2	Project 2: ***Survey the available literature***	20	10	
3	Project 3: ***Critically appraise the literature identified***	20	10	
4	Project 4: ***Go for discussions for developing ideas***	20	10	
5	Project 5: ***Rephrase the research problem into a working proposition***	20	10	
6	Quizes at end of each unit (4 tests, 10 marks each)	40	10	20
7	Mid Review Test	20	10	
Total Formative Assessment				70

Summative assessment				
SN	Component	Marks	Duration	Weightage
1	End Semester Examination	50	2 Hours	30

Text Books

1. Gupta S. C. and Kapoor V. K, Fundamentals of Mathematical Statistics, Sultan Chand & Company New Delhi.
2. Kothari C R, Research Methodology (Methods and Techniques), 2004, New Age International Publishers, New Delhi.

References

1. Pannnerselvam, R Research Methodology, 2014, Phi Learning Private Limited, Delhi.
2. Saravanavel P, Research Methodology, 2011, Kitab Mahal, Allahabad.
3. Kumar R. Research Methodology, 2011, SAGE Publications Asia-Pacific Ptd Singapore.
4. Singh Yogesh Kumar, 2011, Fundamental of Research Methodology and Statitics, New Age International Publishers, New Delhi.
5. Michael V P 2000, Research Methodology in Management Himalaya Publishing House, Mumbai.
6. Pannnerselvam, R Research Methodology, 2014, Phi Learning Private Limited, Delhi.

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS202	Computational Fluid Dynamics	3	-	2	4	Theory & Practical	FA	50	50%	40%	40%
							SA	100	50%	40%	

Course Outcomes: After the completion of this course, the student will able to,

CO1 **Explain[2]** numerical solutions of CFD .

CO2 **Apply[3]** various grid generation techniques.

CO3 **Create[4]** numerical modeling and its role in the field of fluid flow and heat transfer

CO4 **Apply[3]** various convection energy methods, time dependent method and panel methods in Computational fluid dynamic problems..

Unit No	Contents	Lecture Hrs
1	**NUMERICAL SOLUTIONS OF SOME FLUID DYNAMICAL PROBLEMS** Basic fluid dynamics equations, Equations in general orthogonal coordinate system, Body fitted coordinate systems, Stability analysis of linear system. Finding solution of a simple gas dynamic problem, Local similar solutions of boundary layer equations, Numerical integration and shooting technique. Numerical solution for CD nozzle isentropic flows and local similar solutions of boundary layer equations.	6
2	**GRID GENERATION** Need for grid generation – Various grid generation techniques – Algebraic, conformal and numerical grid generation – importance of grid control functions – boundary point control – orthogonality of grid lines at boundaries. Elliptic grid generation using Laplace's equations for geometries like airfoil and CD nozzle.	7
3	**TRANSONIC RELAXATION TECHNIQUES** Small perturbation flows, Transonic small perturbation (TSP) equations, Central and backward difference schemes, conservation equations and shock point operator, Line relaxation techniques, Acceleration of convergence rate, Jameson's rotated difference scheme -stretching of coordinates, shock fitting techniques Flow in body fitted coordinate system.	7
4	**CONVECTION ENERGY EQUATION METHODS** Numerical solution of 1-D conduction- convection energy equation using time dependent methods using both implicit and explicit schemes – application of time split method for the above equation and comparison of the results.	6
5	**TIME DEPENDENT METHODS** Stability of solution, Explicit methods, Time split methods, Approximate factorization scheme, Unsteady transonic flow around airfoils. Sometime dependent solutions of gas dynamic problems. Numerical solution of unsteady 2-D heat conduction problems using SLOR methods	7

6 PANEL METHODS **7**

Elements of two and three dimensional panels, panel singularities. Application of panel methods to incompressible, compressible, subsonic and supersonic flows. Numerical solution of flow over a cylinder using 2-D panel methods using both vertex and source panel methods for lifting and non-lifting cases respectively.

Textbook/s

1 **H.J. Wirz and J.J. Smeldern** "Numerical Methods in Fluid Dynamics", McGraw-Hill & Co., 1978.

2 **John D. Anderson,** JR" Computational Fluid Dynamics", McGraw-Hill Book Co., Inc., New York,

Reference Books

1 **T.J. Chung,** Computational Fluid Dynamics, Cambridge University Press, 2002

2 **C.Y.Chow,** "Introduction to Computational Fluid Dynamics", John Wiley, 1979.

3 **A.A. Hirsch,** 'Introduction to Computational Fluid Dynamics", McGraw-Hill, 1989.

4 **T.K.Bose,** "Computation Fluid Dynamics" Wiley Eastern Ltd., 1988.

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS203	Hypersonic Aerodynamics	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	

Course Outcomes: After the completion of this course, the student will able to,

CO1 **Explain[2]** the fundamental knowledge of hypersonic flows

CO2 **Explain[2]** the surface inclination methods

CO3 **Calculate[3]** the characteristics of hypersonic flow by using approximate methods

CO4 **Select[4]** the appropriate hypersonic viscous flow analysis

CO5 **Select[4]** the experimental measurement devices for hypersonic flow

Unit No	Contents	Lecture Hrs
1	**BASICS OF HYPERSONIC AERODYNAMICS** Thin shock layers – entropy layers – low density and high density flows – hypersonic flight paths hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.	6
2	**SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS** Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties	6
3	**APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS** Approximate methods hypersonic small disturbance equation and theory – thin shock layer theory – blast wave theory - entropy effects - rotational method of characteristics - hypersonic shock wave shapes and correlations.	8
4	**VISCOUS HYPERSONIC FLOW THEORY** Navier–Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating – heat flux estimation.	6
5	**VISCOUS INTERACTIONS IN HYPERSONIC FLOWS** weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Estimation of hypersonic boundary layer transition- Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.	8
6	**Experimental Methods** Hypersonic Tunnels, Components and operation, Testing Procedure, Hypersonic reverse Engine, Problems Associated with hypersonic flows	6

Textbook/s

1 John D. Anderson, Jr, Hypersonic and High Temperature Gas Dynamics, McGraw-Hill Series, New York, 1996.

2 John.D.Anderson, Jr., Modern Compressible Flow with Historical perspective Hypersonic Series.

Reference Books

1 William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series.

2 John T. Bertin, Hypersonic Aerothermodynamics, 1994 AIAA Inc., Washington

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS204	Satellite Technology	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	

Course Outcomes: After the completion of this course, the student will able to,

CO1 **Explain**[2] the fundamental concept of satellite technology

CO2 **Explain**[2] power system and its applications in satellites

CO3 **Analyze** [3] the attitude and Orbit Control System

CO4 **Select**[4] the function and operation of different system in aircraft

Unit No	Contents	Lecture Hrs
1	**SATELLITE MISSION AND CONFIGURATION** Mission Overview – Requirements for different missions – Space Environment, Spacecraft configuration- Spacecraft Bus – Payload – Requirements and constraints – Initial configuration decisions and Trade-offs – Spacecraft configuration process – Broad design of Spacecraft Bus – Subsystem layout – Types of Satellites – Constellations – Applications	6
2	**POWER SYSTEM** Power sources – Energy storage – Solar panels – Deployable solar panels – Spacecraft Power management – Power distribution – Deep Space Probes	6
3	**ATTITUDE AND ORBIT CONTROL SYSTEM** Coordinate system – AOCS requirements – Environment effects – Attitude stabilization – Attitude sensors – Actuators – Design of control algorithms.	8
4	**PROPULSION SYSTEMS, STRUCTURES** Systems Trade-off – Mono-propellant systems – Thermal consideration – System integration design factors – Pre-flight test requirements – System reliability Configuration design of Spacecraft structure – Structural elements – Material selection – Environmental Loads -Vibrations – Structural fabrication.	6
5	**THERMAL CONTROL** Orbital environments - Average temperature in Space – Transient temperature evaluation – Thermal control techniques – Temperature calculation for a spacecraft – Thermal design and analysis program structure – Thermal design verification – Active thermal control techniques.	8
6	**TELEMETRY SYSTEMS** Base Band Telemetry system – Modulation – TT & C RF system – Telecommand system – Ground Control Systems	6

Textbook/s

1 Space Mission Analysis and Design (Third Edition) by James R.Wertz and Wiley J.Larson – 1999.

2 James R.Wertz "Spacecraft Attitude Determination and Control", Kluwer Academic Publisher, 1988.

Reference Books

1 Marcel J.Sidi "Spacecraft Dynamics and Control", Cambridge University press, 1997.

2 Lecture notes on " Satellite Architecture", ISRO Satellite Centre Bangalore

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS205A	Propellant Technology	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	

Course Outcomes: After the completion of this course, the student will able to,

CO1 **Explain[2]** various types of aircraft and spacecraft fuels.

CO2 **Explain2** various types of solid propellants.

CO3 **Describe[2]** properties of cryogenic propellants.

CO4 **Describe[3]** the studies of ignition of liquid propellants.

CO5 **Analyze[4]** thermo-gravimetric propellant testing.

Unit No	Contents	Lecture Hrs
1	**LIQUID FUELS** Properties and tests for petroleum products, Motor gasoline, Aviation gasoline, Aviation turbine fuels, Requirements of aviation fuels of kerosene type and high flash point type, Requirements for fuel oils.	6
2	**SOLID PROPELLANTS** Single base propellants, Double base propellants, Composite propellants, CMBD propellants, Metallized composite propellants. Introduction to different fuels and oxidizers of composite propellants. Brief introduction to composite theory of composite and double base propellants.	6
3	**CRYOGENIC PROPELLANTS** Introduction to cryogenic propellants, Liquid hydrogen, liquid oxygen, liquid nitrogen and liquid nitrogen and liquid helium and their properties.	8
4	**LIQUID PROPELLANTS** Various liquid propellants and their properties, Monopropellants and bipropellant system, concept of ullage, Ignition studies of liquid propellants. Propellant loading tolerances, inventory, Volume versus mass loading. Loading measurement and control, Outage control.	6
5	**PROPELLANT TESTING** Laboratory testing, Arc Image Furnace, Ignitability studies. Differential Thermal Analysis, Thermo-gravimetric analysis, Particle size measurement Micro-merograph, Strand burner tests impulse bomb, Performance estimation.	8
6	**THEORY OF PROPELLANTS** Behind the production of low temperature, Expansion engine, Cascade process, Joule Thompson effect, Magnetic effect, Ortho and para H2, Helium 4 and Helium 3. Ideal cycles and efficiency of cryo systems, Storing of cryogenic propellants, Cryogenic loading problems.	6

Textbook/s

1 **Cornelissse J. W.** (1980), Rocket Propulsion and Space Dynamics, Pitman Publishing, London.

Reference Books

1 **Shutton, G. P.** (2010), Rocket Propulsion Elements, John Wiley / BSP Books, USA.

2 **Samir Sarkar** (2009), Fuels and Combustion, 3rd edition, Universities Press /CRC Press, New York

3 **Mathur M, Sharma R. P.** (2010), Gas Turbine and Jet and Rocket Propulsion, Standard Publishers, New Delhi.

Course Code	Course Title	L	T	P	C	Evaluation Scheme					
						Component	Exam	Marks	WT (%)	Mini. Passing %	
PAS205B	Aerospace Navigation	3	1	-	4	Theory & Tutorial	FA	50	50%	40%	40%
							SA	100	50%	40%	

Course Outcomes: After the completion of this course, the student will able to,

CO1 **Explain[2]** the fundamental concept of Navigation

CO2 **Explain[2]** gyro system and its applications

CO3 **Analyze [3]** the inertial navigation systems

CO4 **Select[4]** the GPS systems for manned and unmanned vehicles

CO5 **Select[4]** the related navigation systems

Unit No	Contents	Lecture Hrs
1	**NAVIGATION CONCEPTS** Fundamentals of spacecraft navigation systems and Position Fixing – Geometric concepts of Navigation – Elements - The Earth in inertial space - Earth's Rotation - Revolution of Earth - Different Coordinate Systems – Coordinates Transformation - Euler angle formulations - Direction cosine formulation - Quaternion formulation.	6
2	**GYRO SYSTEMS** Gyroscopes -Types – Mechanical - Electromechanical-Optical Gyro -Ring Laser gyro-Fiber optic gyro - Rate Gyro, Rate Integrating Gyro, Free Gyro, Vertical Gyro, Directional Gyro, Analysis & Applications	6
3	**INERTIAL NAVIGATION SYSTEMS** Accelerometers – Pendulous type – Force Balance type – MEMs Accelerometers - Basic Principles of Inertial Navigation – Types - Platform and Strap down - Mechanization INS system - Rate Corrections - Block diagram – Acceleration errors – -Coriolis effect - Schuler Tuning - Cross coupling - Gimbal lock - Alignment	8
4	**GPS & HYBRID NAVIGATION SYSTEMS** GPS overview – Concept – GPS Signal – Signal Structure- GPS data – Signal Processing – GPS Clock – GPS for position and velocity determination – DGPS Concepts - LAAS & WAAS Technology - Hybrid Navigation - Introduction to Kalman filtering – Case Studies -Integration of GPS and INS using Kalman Filter	6
5	**RELATIVE NAVIGATION SYSTEMS** Relative Navigation – fundamentals – Equations of Relative Motion for circular orbits (Clohessy_Wiltshire Equations) - Sensors for Rendezvous Navigation - RF Sensors - Relative Satellite Navigation - Differential GSP - Relative GPS- Optical rendezvous sensors (Laser type and Camera type) -Formation Flying - Figure of Merit (FOM)	8
6	**UAV NAVIGATION** Geometric guidance, path planning and following, and optimal guidance; path planning for UGV/UAV guidance systems.SLAM (Simultaneous Localization and Mapping); Cooperative guidance and collision avoidance.	6

Textbook/s

1 **Maxwell Noton**, "Spacecraft navigation and guidance", Springer (London, New York), 1998

2 **Slater, J.M. Donnel,** "Inertial Navigation Analysis and Design", McGraw-Hill Book Company, New York, 1964.

3 **Albert D. Helfrick,** 'Modern Aviation Electronics', Second Edition, Prentice Hall Career & Technology, 1994

Reference Books

1 **George M Siouris,** 'Aerospace Avionics System; A Modern Synthesis', Academic Press Inc., 1993

2 **Myron Kyton, Walfred Fried,** 'Avionics Navigation Systems', John Wiley & Sons, 1997