LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
(AUTONOMOUS)
L.B.Reddy Nagar, Mylavaram – 521 230, N.T.R. District, Andhra Pradesh, India
Affiliated to JNTUK, Kakinada & Approved by AICTE New Delhi
Accredited by NAAC with 'A' grade, An ISO 9001:2015 Certified Institution
DEPARTMENT OF AEROSPACE ENGINEERING
Website: https://www.lbrce.ac.in/ase/index.php Email: hodaero@lbrce.ac.in Phone:08659-222933 Ext:624/623

COURSE HANDOUT
PART-A

Name of Course Instructor : Mr. G V SURYA NARAYANA
Course Name & Code : **MOC_17AE24**
L-T-P Structure : 2-2-0 Credits : 3
Program/Sem/Sec : B.Tech., VII-Sem. A.Y : 2022-23

PRE-REQUISITE: Strength of materials

COURSE EDUCATIONAL OBJECTIVES (CEOs): To Learn the basic knowledge about composite materials at micro and macro level, lamina and laminates, basic design concepts of sandwich panels, functionally graded materials, and the manufacturing process of composite materials.

COURSE OUTCOMES (COs): At the end of the course, students are able to

CO1	Understand the stress-strain relations applicable for composite materials (Understanding-L2)
CO2	Study the macro and micro mechanical behaviour of composite Lamina (Apply-L3)
CO3	Analyze the structural behaviour of multi directional composites (Analyze-L4)
CO4	Understand the basic design concept of sandwich panels used in aerospace industries (Understanding-L2)
CO5	Apply techniques of fabrication processes to manufacture composites (Apply-L3)

COURSE ARTICULATION MATRIX (Correlation between COs, POs & PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	-	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	-	-	-	-	-	-	-	2	3	2
CO3	3	3	3	2	-	-	-	-	-	-	-	2	3	2
CO4	3	3	3	2	-	-	-	-	-	-	-	2	3	2
CO5	2	2	2	2	-	-	-	-	-	-	-	2	2	2

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
1- Slight (Low), **2 –** Moderate (Medium), **3 -** Substantial (High).

TEXTBOOKS:

T1 Calcote, LR., "The Analysis of laminated Composite Structures", Von – Noastrand Reinhold Company, New York 1998.
T2 Jones, R.M., "Mechanics of Composite Materials", 2nd Edition McGraw-Hill, KogakushaLtd., Tokyo, 1998.
T3 Carlsson, L.A., Kardomateas, G.A., "Structural and Failure Mechanics of Sandwich", Solid Mechanics and its Applications, Vol 121, Springer Heidlberg, New York, 2011.

REFERENCE BOOKS:

R1 Agarwal, B.D., Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.

R2 Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co.,New York, 1989.Publishers,3rd edition 2010.

PART-B

COURSE DELIVERY PLAN (LESSON PLAN)

UNIT-I: STRESS STRAIN RELATION

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction to composite materials	1	11-07-22		TLM1, TLM2	
2.	Classification of Reinforcements	2	13-07-22 14-07-22		TLM1, TLM2	
3.	Advantages and applications	1	15-07-22		TLM1, TLM2	
4.	Types of Fibers	2	16-07-22 18-07-22		TLM2	
5.	Fiber's applications	1	20-07-22		TLM1	
6.	Classification based on matrices	2	21-07-22 22-07-22		TLM1	
7.	Types of matrices	1	23-07-22		TLM1, TLM2	
8.	Matrices applications	1	25-07-22		TLM1	
9.	Generalized Hooke's Law	1	27-07-22		TLM1	
10.	Compliance stiffness matrix	2	28-07-22 29-07-22		TLM1	
11.	Reduced stiffness matrix	2	30-07-22 01-08-22		TLM1, TLM2	
12.	Stress strain relations for non-isotropic materials	2	03-08-22 04-08-22		TLM1, TLM2	
13.	Stress strain relations for orthotropic lamina materials, Assignment-I	1	05-08-22		TLM1, TLM2	
No. of classes required to complete UNIT-I: 19				No. of classes taken:		

UNIT-II: METHODS OF ANALYSIS

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
14.	Introduction to macro mechanics	1	06-08-22		TLM1, TLM2	
15.	Stress-strain relations	2	08-08-22 10-08-22		TLM1, TLM2	
16.	Mechanics of materials approach	2	11-08-22 12-08-22		TLM1, TLM2	

17.	Problem solving	1	13-08-22		TLM1, TLM2	
18.	Elasticity approach to materials	1	17-08-22		TLM1, TLM2	
19.	Determination of material properties	2	18-08-22 20-08-22		TLM1, TLM2	
20.	Problem solving	1	22-08-22		TLM1, TLM2	
21.	Introduction to micro mechanics	1	24-08-22		TLM1, TLM2	
22.	Problem solving	1	25-08-22		TLM1, TLM2	
23.	Experimental characterization	2	26-08-22		TLM1, TLM2	
24.	Problems on lamina properties	1	27-08-22		TLM1	
25.	Problem solving	1	29-08-22		TLM1, TLM2	
26.	Determine elastic constants	2	01-09-22 02-09-22		TLM1	
27.	Problem solving, Assignment-II	1	03-09-22		TLM1	
No. of classes required to complete UNIT-II:19				No. of classes taken:		

UNIT-III: MULTI DIRCTIONAL COMPOSITES

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
28.	Introduction to laminate	1	26-09-22		TLM1, TLM2	
29.	Governing differential equation for a general laminate,	2	28-09-22 29-09-22		TLM1, TLM2	
30.	Classical Lamination Theory	1	30-09-22		TLM1, TLM2	
31.	Symmetric, Antisymmetric laminates,	1	01-10-22		TLM1, TLM2	
32.	CLT	1	03-10-22		TLM2	
33.	A, B, D matrices	1	06-10-22		TLM1	
34.	angle ply laminates	1	07-10-22		TLM2	
35.	A, B, D matrices angle ply laminates	1	08-10-22		TLM1, TLM2	
36.	Cross ply laminates	1	10-10-22		TLM2	

37.	A, B, D matrices Cross ply laminates	1	12-10-22		TLM1, TLM2	
38.	Failure criteria and strength of laminates	1	13-10-22		TLM1, TLM2	
39.	Failure theories (T-Sai. T-sai-Wu etc.) Assignment-III	1	14-10-22		TLM1, TLM2	
No. of classes required to complete UNIT-III:13				No. of classes taken:		

UNIT-IV: SANDWICH CONSTRUCTIONS

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
40.	Introduction to sandwich construction	1	15-10-22		TLM1, TLM2	
41.	Design concepts of sandwich panels	1	17-10-22		TLM1, TLM2	
42.	Facing and core Materials	2	19-10-22 20-10-22		TLM1	
43.	Flexural rigidity of sandwich	1	21-10-22		TLM1	
44.	deflection of sandwich beams	1	22-10-22		TLM1	
45.	Problems on sandwich panels	1	26-10-22		TLM1	
46.	Applications of Sandwich panels	1	27-10-22		TLM1, TLM2	
47.	Failure modes of sandwich panels	1	28-10-22		TLM1, TLM2	
48.	Failure modes of sandwich panels, Assignment-IV	1	29-10-22		TLM1, TLM2	
No. of classes required to complete UNIT-IV:10				No. of classes taken:		

UNIT-V: FABRICATION PROCESSES & FUNCTIONALLY GRADED MATERIALS:

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
49.	**FABRICATION PROCESSES:** Introduction to fabrication process	1	31-10-22		TLM1 TLM2	
50.	Fibers-Glass, Carbon, and Boron	1	02-11-22		TLM1, TLM2	
51.	Laminate Composite	1	03-11-22		TLM1, TLM2	

52.	Various Open mould processes	1	04-11-22		TLM1, TLM2	
53.	Various closed mould processes	1	05-11-22		TLM1, TLM2	
54.	lay-up process	1	07-11-22		TLM1, TLM2	
55.	Vacuum bagging, infusion	1	09-11-22		TLM1, TLM2	
56.	Pultrusion,	1	11-11-22		TLM1, TLM2	
57.	RTM	1	12-11-22		TLM1, TLM2	
58.	Auto Clave	1	14-11-22		TLM1, TLM2	
59.	Filament Winding	1	16-11-22		TLM1, TLM2	
60.	FUNCTIONALLY GRADED MATERIALS: Introduction to FGM's	1	17-11-22		TLM1	
61.	lengthwise and thickness wise	1	18-11-22		TLM1	
62.	power law. Assignment-V	1	19-11-22		TLM1	
No. of classes required to complete UNIT-V:14				No. of classes taken:		

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

PART-C

EVALUATION PROCESS (R17 Regulations):

Evaluation Task	**Marks**
Assignment-I (Unit-I)	A1=5
Assignment-II (Unit-II)	A2=5
I-Mid Examination (Units-I & II)	M1=20
I-Quiz Examination (Units-I & II)	Q1=10
Assignment-III (Unit-III)	A3=5
Assignment-IV (Unit-IV)	A4=5
Assignment-V (Unit-V)	A5=5
II-Mid Examination (Units-III, IV & V)	M2=20
II-Quiz Examination (Units-III, IV & V)	Q2=10
Attendance	B=5
Assignment Marks = Best Four Average of A1, A2, A3, A4, A5	A=5
Mid Marks =75% of Max (M1, M2) +25% of Min (M1, M2)	M=20

Quiz Marks =75% of Max (Q1, Q2) +25% of Min (Q1, Q2)	B=10
Cumulative Internal Examination (CIE): A+B+M+Q	40
Semester End Examination (SEE)	60
Total Marks = CIE + SEE	100

PART-D

PROGRAMME OUTCOMES (POs):

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

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1	To apply the knowledge of Aerodynamics, Propulsion, Aircraft structures, and Flight Dynamics in Aerospace vehicle design.
PSO2	To prepare the students to work effectively in Aerospace and Allied Engineering organizations.

Course Instructor	Course Coordinator	Module Coordinator	HOD
(Mr. G V Surya Narayana)	(Mr. G V Surya Narayana)	(Dr. L. Prabhu)	(Dr. P. Lovaraju)

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DEPARTMENT OF AEROSPACE ENGINEERING

COURSE HANDOUT

PART-A

Name of Course Instructor : Dr. L. Prabhu
Course Name & Code : Theory of Vibrations / 17AE33
L-T-P Structure : 3-0-0 Credits : 3
Program/Sem/Sec : B.Tech., Aerospace, VII-Sem A.Y : 2022-23

PRE-REQUISITE: Engineering Mechanics, Strength of Materials

COURSE EDUCATIONAL OBJECTIVES (CEOs):

1. To construct a free body diagram and write the differential equations of motion of vibratory system to find natural frequency.
2. To learn the effects of damped free vibrations of single degree of freedom systems.
3. To understand the forced vibrations of unbalanced system and knowing about isolators, vibration measuring instruments.
4. To learn about the two degree of freedom systems of forced vibrations with harmonic excitation.
5. To learn about multi degree of freedom systems by applying exact analysis, influence coefficients and numerical methods.

COURSE OUTCOMES (COs): At the end of the course, students are able to

CO 1	Formulate mathematical models for mechanical systems using mass, spring and dampers (Apply-L3)
CO 2	Analyze a systems with damped free vibrations single degree of freedom (Apply-L3)
CO 3	Develop a single degree of freedom forced vibrating mechanical system under various types of excitation conditions (Apply-L3)
CO 4	Analyze and modify two degree of freedom mechanical systems (Apply-L3)
CO 5	Analyze a systems of multi degrees of freedom (Apply-L3)

COURSE ARTICULATION MATRIX (Correlation between COs, POs & PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	-	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	-	-	-	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	-	-	-	-	-	-	-	2	3	3

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
1- Slight (Low), **2** – Moderate (Medium), **3** - Substantial (High).

REFERENCE BOOKS:

R1 Thomson. W. T., Theory of Vibrations with Applications, CBS Publishers & Distributors, 2002.
R2 Grover. G. K., Mechanical Vibrations: M.K.S. Systems, Nemchand & Bros., 1972.
R3 Singh. V. P., Mechanical Vibrations, Dhanpati Rai & Sons, 2016.
R4 Rao. V. D., Srinivas. J., Textbook of Vibrations, PHI Learning Pvt. Ltd., 2004.
R5 Rao. S. S., Mechanical Vibrations, Prentice Hall, 2011.

PART-B

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction to vibration	1	11-07-2022		TLM1	
2.	Basic terminology	1	12-07-2022		TLM1	
3.	Formation of differential equation	1	13-07-2022		TLM1	
4.	Solution of differential equation	1	14-07-2022		TLM1	
5.	Torsional vibration	1	16-07-2022		TLM1	
6.	Tutorial I	1	18-07-2022		TLM3	
7.	Springs in series	1	19-07-2022		TLM1	
8.	Springs in parallel		20-07-2022			
9.	Natural frequency of a vibration system by energy method	2	21-07-2022 23-07-2022		TLM1	
10.	Tutorial II	1	25-07-2022		TLM3	
11.	Discussion	1	26-07-2022		TLM1	
12.	Quiz and Assignment - 1	1	27-07-2022			
No. of classes required to complete UNIT-I: 13				No. of classes taken:		

UNIT-II:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
13.	Introduction to damped free vibration	1	28-07-2022		TLM1	
14.	Classification of dampers	1	30-07-2022		TLM1	
15.	Free vibration with viscous dampers	1	01-08-2022		TLM1	
16.	Problems	1	02-08-2022		TLM1	
17.	Tutorial III	1	03-08-2022		TLM3	
18.	Underdamped system	2	04-08-2022 06-08-2022		TLM1	
19.	Critically damped system	1	08-08-2022		TLM1	
20.	Overdamped system	2	10-08-2022 11-08-2022		TLM1	
21.	Problems	1	16-08-2022		TLM1	
22.	Tutorial IV	1	17-08-2022		TLM3	
23.	Logarithmic decrement	1	18-08-2022		TLM1	
24.	Problems	1	20-08-2022		TLM1	
25.	Viscous dampers	1	23-08-2022		TLM1	
26.	Dry friction damper	1	24-08-2022		TLM1	
27.	Structural damper	1	25-08-2022		TLM1	
28.	Problems	1	27-08-2022		TLM1	
29.	Assignment/Quiz-2	1	29-08-2022		TLM1	
30.	***Revision (Unit 1 and Unit 2)***	1	30-08-2022		TLM1	
31.		1	01-09-2022		TLM1	
32.		1	03-09-2022		TLM1	
No. of classes required to complete UNIT-II:19				No. of classes taken:		

UNIT-III:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
33.	Introduction to forced vibration	1	26-09-2022		TLM1	
34.	Types of forced excitation	1	27-09-2022		TLM1	
35.	Forced vibrations with constant harmonic excitation	1	28-09-2022		TLM1	
36.	Steady state vibrations	1	29-09-2022		TLM1	
37.	Problems	1	01-10-2022		TLM1	
38.	Forced vibration with rotating and reciprocating unbalance	1	06-10-2022		TLM1	
39.	Tutorial V	1	07-10-2022		TLM3	
40.	Forced vibrations due to excitation of the	1	10-10-2022		TLM1	
41.	Vibration isolation and transmissibility	1	11-10-2022		TLM1	
42.	Problems	1	12-10-2022		TLM1	
43.	vibration measuring instruments	1	13-10-2022		TLM1	
44.	Tutorial VI	1	15-10-2022		TLM3	
45.	Assignment/Quiz 3	1	17-10-2022			
No. of classes required to complete UNIT-III:13				No. of classes taken:		

UNIT-IV:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
46.	Introduction to two degree of freedom	1	18-10-2022		TLM1	
47.	Two masses fixed on a tightly stretched string	1	19-10-2022		TLM1	
48.	Double pendulum	1	20-10-2022		TLM1	
49.	Problems	1	22-10-2022		TLM1	
50.	Tutorial VII	1	25-10-2022		TLM3	
51.	Torsional system	1	26-10-2022		TLM1	
52.	Undamped forced vibrations with harmonic excitation	2	27-10-2022 29-10-2022		TLM1	
53.	Undamped dynamic vibration absorber	1	31-10-2022		TLM1	
54.	Problems	1	01-11-2022		TLM1	
55.	Tutorial VIII	1	02-11-2022		TLM3	
56.	Assignment/Quiz 4	1	03-11-2022		TLM1	
No. of classes required to complete UNIT-IV:12				No. of classes taken:		

UNIT-V:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
57.	Introduction to Multi degree of freedom	1	05-11-2022		TLM1	
58.	Influence coefficients	1	07-11-2022		TLM1	
59.	Flexibility coefficients and Maxwell reciprocal theorem	1	08-11-2022		TLM1	
60.	Problems	1	09-11-2022		TLM1	
61.	Tutorial IX	1	10-11-2022		TLM3	
62.	Torsional vibrations of Multi rotor systems	1	14-11-2022		TLM1	

63.	Vibrations of geared systems	1	15-11-2022		TLM1	
64.	Determination of natural frequency of vibration by Rayleigh's method.	1	16-11-2022		TLM1	
65.	Tutorial X	1	17-11-2022		TLM3	
66.	Assignment/Quiz 5	1	19-11-2022		TLM1	
No. of classes required to complete UNIT-V:10				No. of classes taken:		

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

PART-C

EVALUATION PROCESS (R17 Regulations):

Evaluation Task	**Marks**
Assignment-I (Unit-I)	A1=5
Assignment-II (Unit-II)	A2=5
I-Mid Examination (Units-I & II)	M1=20
I-Quiz Examination (Units-I & II)	Q1=10
Assignment-III (Unit-III)	A3=5
Assignment-IV (Unit-IV)	A4=5
Assignment-V (Unit-V)	A5=5
II-Mid Examination (Units-III, IV & V)	M2=20
II-Quiz Examination (Units-III, IV & V)	Q2=10
Attendance	B=5
Assignment Marks = Best Four Average of A1, A2, A3, A4, A5	A=5
Mid Marks =75% of Max(M1,M2)+25% of Min(M1,M2)	M=20
Quiz Marks =75% of Max(Q1,Q2)+25% of Min(Q1,Q2)	B=10
Cumulative Internal Examination (CIE) : A+B+M+Q	40
Semester End Examination (SEE)	60
Total Marks = CIE + SEE	100

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethic**s: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1	To Apply the knowledge of Aerodynamics, Propulsion, Aircraft structures and Flight Dynamics in the Aerospace vehicle design.
PSO 2	To prepare the students to work effectively in Aerospace and Allied Engineering organizations.

Dr. L. Prabhu			Dr. P. Lovaraju
Course Instructor	Course Coordinator	Module Coordinator	HOD

LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
(AUTONOMOUS)
Accredited by NAAC & NBA (CSE, IT, ECE, EEE & ME)
Approved by AICTE, New Delhi and Affiliated to JNTUK, Kakinada
L.B.Reddy Nagar, Mylavaram-521230, Krishna Dist, Andhra Pradesh, India

DEPARTMENT OF AEROSPACE ENGINEERING

COURSE HANDOUT

PROGRAM : **B.Tech., VII-Sem., ASE**

ACADEMIC YEAR : **2022-23**

COURSE NAME & CODE : **Computational Fluid Dynamics and 17AE25**

L-T-P STRUCTURE : **3-0-0**

COURSE CREDITS : **3**

COURSE INSTRUCTOR : **Dr. P. Lovaraju**

COURSE COORDINATOR : **Dr. P. Lovaraju**

PRE-REQUISITE:

Course Educational Objectives: To learn the basic governing equations of fluid dynamics, mathematical behaviour of partial differential equations, phenomena of various discretization techniques, techniques to solve the simple incompressible flow problems, and basic techniques to solve simple heat transfer problems .

COURSE OUTCOMES (COs): At the end of the course, students are able to

CO 1	Formulate the basic fluid dynamics problem mathematically (Apply-L3)
CO 2	Analyze the mathematical behaviour of partial differential equations (Analyze-L4)
CO 3	Apply the grid generation principles for different problems (Apply-L3)
CO 4	Solve elementary incompressible fluid problems using the CFD techniques (Apply-L3)
CO5	Solve the elementary heat transfer problems using the CFD techniques (Apply-L3)

Course Code	COs	Programme Outcomes												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
17AE25	CO1	3	2	2	2	1	-	-	-	-	-	-	2	3	3
	CO2	3	3	2	2	1	-	-	-	-	-	-	2	3	3
	CO3	3	2	3	2	3	-	-	-	-	-	-	2	3	3
	CO4	3	2	2	2	3	-	-	-	-	-	-	2	3	3
	CO5	3	2	2	2	3	-	-	-	-	-	-	2	3	3
1 = Slight (Low) 2 = Moderate (Medium) 3-Substantial (High)															

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-' 1-** Slight(Low), **2 -** Moderate(Medium), **3 -** Substantial (High).

BOS APPROVED TEXT BOOKS:

T1 Anderson.J.D, Computational Fluid Dynamics-Basics with Applications, Mc Graw Hill, 1995.

T2 Thanigaiarasu. S, Computational Fluid Dynamics and Heat Transfer.

BOS APPROVED REFERENCE BOOKS:

R1 Anderson, D. A, Tannehill. J. C, Pletcher. R. H, Computational Fluid Mechanics and Heat Transfer, CRC Press, 2012.

R2 Patankar. S. V, Numerical Heat Transfer and Fluid Flow, CRC Press, 1980.

R3 Sengupta. T. K, Fundamentals of Computational Fluid Dynamics, University Press, 2004.

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: Introduction, Governing Equations of Fluid Dynamics

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
1.	Introduction to Course and discussion of course outcomes (Cos)	1	11-07-2022		**TLM2**	CO1	T1	
2.	Computational Fluid Dynamics as a Research and Design Tool, Applications of Computational Fluid Dynamics.	2	12-07-2022 13-07-2022		**TLM2**	CO1	T1	
3.	Introduction, Control Volume, Substantial Derivative, Divergence of Velocity,	2	14-07-2022 16-07-2022		**TLM2**	CO1	T1	
4.	Continuity Equation	2	18-07-2022 19-07-2022		**TLM2**	CO1	T1	
5.	Momentum Equation	2	20-07-2022 **21-07-2022**		**TLM2**	CO1	T1	
6.	Energy Equation	2	23-07-2022 25-07-2022		**TLM2**	CO1	T1	
7.	Conservation and Non-conservation forms of governing flow equations	2	26-07-2022 28-07-2022		**TLM2**	CO1	T1	
8.	Tutorial	1	30-07-2022		**TLM3**			
9.	Assignment-1/Quiz-1	1	1-08-2022					
No. of classes required to complete UNIT-I:		15	No. of classes taken:					

UNIT-II: Mathematical Behavior of Partial Differential Equations

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
1.	Introduction	1	2-08-2022		**TLM2**	**CO2**	**T1**	
2.	Classification of Quasi-Linear Partial Differential Equations	2	3-08-2022 4-08-2022		**TLM2**	**CO2**	**T1**	
3.	Eigen Value Method	2	6-08-2022 10-08-2022		**TLM2**	**CO2**	**T1**	
4.	Hyperbolic Equations	2	11-08-2022 12-08-2022		**TLM2**	**CO2**	**T1**	
5.	Parabolic Equations	2	16-08-2022 17-08-2022		**TLM2**	**CO2**	**T1**	
6.	Elliptic Equations	2	20-08-2022 22-08-2022		**TLM2**	**CO2**	**T1**	
7.	Tutorial	1	23-08-2022		TLM3		T1	
8.	Assignment-2/Quiz-2	1	24-08-2022					
No. of classes required to complete UNIT-II:		13	No. of classes taken:					

I MID EXAMINATIONS (19-09-2022 TO 24-09-2022)

UNIT-III: Basics Aspects of Discretization

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
1.	Introduction of Finite Differences	2	25-08-2022 27-08-2022		TLM2	CO3	T1	
2.	Difference Equations Forward Difference and Rearward Difference	2	29-08-2022 30-08-2022		TLM2	CO3	T1	
3.	Central Difference	1	1-09-2022		TLM2	CO3	T1	
4.	Explicit and Implicit Approaches	2	2-09-2022 3-09-2022		TLM2	CO3	T1	
5.	Errors	2	26-09-2022 27-09-2022		TLM2	CO3	T1	
6.	Stability Analysis	1	28-09-2022		TLM2	CO3	T1	
7.	Grid Generation. General transformation of equations,	2	29-09-2022 10-10-2022		TLM2	CO3	T1	
8.	Matrics and Jacobians	2	11-10-2022 12-10-2022		TLM2			
9.	Tutorial	1	13-10-2022		TLM3			
10.	Assignment-3/Quiz 3	1	15-10-2022					
No. of classes required to complete UNIT-III:		16	No. of classes taken:					

UNIT-IV : Incompressible Fluid Flow

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
1.	Introduction	1	17-10-2022		TLM2	CO4	T1	
2.	Maccromack's Technique	2	18-10-2022 19-10-2022		TLM2	CO4	T1	
3.	Predictor step and Corrector Step	1	20-10-2022		TLM2	CO4	T1	
4.	Incompressible Couette Flow, Implicit Crank-Nicholson Technique	2	22-10-2022 25-10-2022		TLM2	CO4	T1	
5.	Pressure Correction Method	1	26-10-2022		TLM2	CO4	T1	
6.	Computation of Boundary Layer Flows	1	27-10-2022		TLM2	CO4	T1	
7.	Tutorial	1	29-10-2022		TLM3			
8.	Assignment-4/Quiz 4	1	31-10-2022					
No. of classes required to complete UNIT-IV:		10	No. of classes taken:					

5-09-2022 to 17-09-2022 CRT

UNIT-V : Heat Transfer

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
1.	Finite Difference Applications in Heat conduction and Convention,	2	1-11-2022 2-11-2022		TLM2	CO5	T2, R1	
2.	Heat conduction - steady heat conduction in a rectangular geometry	2	3-11-2022 5-11-2022		TLM2	CO5	T2, R1	
3.	Transient heat conduction in a plane wall	2	7-11-2022 8-11-2022		TLM2	CO5	T2, R1	
4.	Two-Dimensional transient heat conduction,	2	9-11-2022 10-11-2022		TLM2	CO5	T2, R1	
5.	Finite difference application in convective heat transfer.	1	14-11-2022		TLM2	CO5	T2, R1	
6.	Tutorial	1	15-11-2022		TLM3			
7.	Assignment-5/Quiz 5	1	16-11-2022					
8.	Revision	2	17-11-2022 18-11-2022		TLM2			
No. of classes required to complete UNIT-V:12		13	No. of classes taken:					

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

ACADEMIC CALENDAR:

Description	From	To	Weeks
I Phase of Instructions-1	11-07-2022	3-09-2022	8W
CRT	5-09-2022	17-09-2022	2W
I Mid Examinations	19-09-2022	24-09-2022	1W
II Phase of Instructions	26-09-2022	19-11-2022	8W
II Mid Examinations	21-11-2022	26-11-2022	1W
Preparation and Practical	28-11-2022	3-12-2022	1W
Semester End Examinations	5-12-2022	17-12-2022	2W

EVALUATION PROCESS:

Evaluation Task	COs	Marks
Assignment/Quiz – 1	1	A1=5
Assignment/Quiz – 2	2	A2=5
I-Mid Examination	1,2	B1=20
I-Mid Examination(Objective)	1,2	C1=10
Assignment/Quiz – 3	3	A3=5
Assignment/Quiz – 4	4	A4=5
Assignment/Quiz – 5	5	A5=5
II-Mid Examination	3,4,5	B2=20
II-Mid Examination(Objective)	3,4,5	C2=10
Evaluation of Assignment/Quiz Marks: A=(A1+A2+A3+A4+A5)/5	1,2,3,4,5	A=5
Evaluation of Mid Marks: B=75% of Max(B1,B2)+25% of Min(B1,B2)	1,2,3,4,5	B=20
Evaluation of Quiz Marks: C=75% of Max(C1,C2)+25% of Min(C1,C2)	1,2,3,4,5	C=10
Attendance Marks: D(>95%=5, 90-95%=4,85-90%=3,80-85%=2,75-80%=1)		D=5

Cumulative Internal Examination : A+B+C+D	**1,2,3,4,5**	**40**
Semester End Examinations	**1,2,3,4,5**	**E=60**
Total Marks: A+B+C+D+E	**1,2,3,4,5**	**100**

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct Investigation of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including predictions and modeling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: To apply the knowledge of Aerodynamics, Propulsion, Aircraft structures and Flight Dynamics in the Aerospace vehicle design
PSO2: To prepare the students to work effectively in Aerospace and Allied Engineering organizations

Course Instructor	**Module Coordinator**	**HOD**

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COURSE HANDOUT

PROGRAM : B.Tech., VII-Sem., ASE

ACADEMIC YEAR : 2022-23

COURSE NAME & CODE : INTRODUCTION TO SPACE TECHNOLOGY – 17AE28

L-T-P STRUCTURE : 3-0-0

COURSE CREDITS : 3

COURSE INSTRUCTOR : **M.BHUVANESHWARI**

MODULE COORDINATOR: Dr.P.LOVARAJU

PRE-REQUISITE: NONE

COURSE OBJECTIVE: In this course student will be able to learn the space mission strategies and fundamental orbital mechanics. She/he can be able to calculate flight trajectories of rockets and missiles. He will be able to understand the fundamentals of atmospheric re-entry issues and satellite attitude control techniques.

COURSE OUTCOMES (CO)

CO1	Understand the concepts of launching satellites in space (Understand-L2)
CO2	Apply the principles of orbital mechanics on motion of bodies in orbits (Apply-L3)
CO3	Comprehend the trajectories of rockets and missiles (Understand-L2)
CO4	Describe the dynamics of spacecraft attitude (Understand-L2)

COURSE ARTICULATION MATRIX (Correlation between COs&POs,PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	-	-	-	-	-	-	-	2	3	3
CO2	3	3	3	2	-	-	-	-	-	-	-	2	3	3
CO3	3	3	3	2	-	-	-	-	-	-	-	2	3	3
CO4	3	3	3	2	-	-	-	-	-	-	-	2	2	3

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
1- Slight(Low), **2 -** Moderate(Medium), **3 -** Substantial (High).

BOS APPROVED TEXT BOOKS:

T1 W.E.Wiesel, Spaceflight Dynamics, McGraw-Hill,1997

T2 Cornelisse, Schoyer HFR, Wakker KF, Rocket Propulsion and Space Flight Dynamics, pitman publications, 1984

BOS APPROVED REFERENCE BOOKS:

R1 J.Sellers., "Understanding Space: An Introduction to Astronautics", McGraw- Hill, 2000.

R2 Francis J Hale., "Introduction to Space Flight", Prentice-Hall, 1994.

COURSE DELIVERY PLAN (LESSON PLAN)

UNIT-I: INTRODUCTION

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction to origin of space and Space Missions- Types	2	11/07/2022& 12/07/2022		**TLM2**	
2.	Space Environment-Introduction	2	13/07/2022& 14/07/2022		**TLM2**	
3.	Launch vehicle selection	2	16/07/2022& 18/07/2022		**TLM2**	
4.	Introduction to Rocket Propulsion	2	19/07/2022& 20/07/2022		**TLM2**	
5.	Fundamentals of solid Rocket Propellants	2	21/07/2022& 23/07/2022		**TLM2**	
6.	Solid Rocket Propellants- Burn rate & properties	2	25/07/2022& 26/07/2022		**TLM2**	
7.	Fundamentals of Liquid Rocket Propellants	1	27/07/2022		**TLM2**	
8.	Liquid Rocket Propellants-Pump & Pressure Feed Systems	2	28/07/2022& 30/07/2022		**TLM2**	
9.	Rocket Equation	1	01/08/2022		**TLM2**	
10.	REVISION	2	02/08/2022& 03/08/2022			
No. of classes required to complete UNIT-I		18	No. of classes taken:			

UNIT-II: ORBITAL MECHANICS & ORBITAL MANEUVERS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
11.	Two body motion-Inertial Frame	2	04/08/2022& 06/08/2022		**TLM1**	
12.	Two body motion-Angular Momentum & Orbit Eq.	2	08/08/2022& 10/08/2022		**TLM1**	
13.	Conic Sections- Circular Orbits and Elliptical Orbits	2	11/08/2022& 13/08/2022		**TLM1**	
14.	Conic Sections- Parabolic Orbits and - Hyperbolic Orbits	3	16/08/2022& 17/08/2022& 18/08/2022		**TLM1**	
15.	Classic Orbital Elements & Ground Tracks	2	20/08/2022& 22/08/2022		**TLM1**	
16.	Orbital Maneuvers-Hohmann transfer	2	23/08/2022& 24/08/2022		**TLM1**	
17.	Bi-elliptical	2	25/08/2022& 27/08/2022		**TLM1**	
18.	Plane changes and Combined maneuvers	2	29/08/2022& 30/08/2022		**TLM1**	
19.	Propulsion for maneuvers	2	01/09/2022& 03/09/2022			
No. of classes required to complete UNIT-II		19	No. of classes taken:			

UNIT III- ASCENT FLIGHT MECHANICS OF ROCKETS & MISSILES

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
20.	Two-Dimensional trajectories of rockets and missiles	1	26/09/2022		**TLM1**	
21.	Multi-Stage Rockets	2	27/09/2022& 28/09/2022		**TLM1**	
22.	Vehicle Sizing	1	29/09/2022		**TLM1**	
23.	Two-Stage Rockets	1	01/10/2022		**TLM1**	
24.	Trade-off Ratios	2	04/10/2022& 06/10/2022		**TLM1**	
25.	Single Stage to Orbit	1	08/10/2022		**TLM1**	
26.	Sounding Rockets	2	10/10/2022& 11/10/2022		**TLM1**	
27.	Gravity turn trajectories	1	12/10/2022		**TLM1**	
No. of classes required to complete UNIT-III		11	No. of classes taken:			

Unit IV- ATMOSPHERIC REENTRY

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
28.	Introduction to Reentry	1	13/10/2022		**TLM1**	
29.	Steep Ballistic Reentry	2	15/10/2022& 17/10/2022		**TLM1**	
30.	Ballistic Orbital Reentry	2	18/10/2022& 19/10/2022		**TLM1**	
31.	Skip Reentry	2	20/10/2022& 22/10/2022		**TLM1**	
32.	Double Dip Reentry	2	25/10/2022& 26/10/2022		**TLM1**	
33.	Aero Braking	2	27/10/2022& 29/10/2022		**TLM1**	
34.	Lifting Body Reentry	2	31/10/2022& 01/11/2022		**TLM1**	
No. of classes required to complete UNIT-IV		13	No. of classes taken:			

Unit V- SATELLITE ATTITUDE DYNAMICS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
35.	Introduction	1	02/11/2022		**TLM1**	
36.	Torque Free Axi-symmetric Body	2	03/11/2022& 05/11/2022		**TLM1**	
37.	Attitude Control for spinning Spacecraft	2	07/11/2022& 09/11/2022		**TLM1**	

38.	Attitude Control for non-spinning Spacecraft	1	10/11/2022		**TLM1**	
39.	The Yo-Yo Mechanism	2	12/11/2022& 14/11/2022		**TLM1**	
40.	Gravity Gradient Satellite	2	15/11/2022& 16/11/2022		**TLM1**	
41.	Dual Spin Spacecraft- Attitude Determination	2	17/11/2022& 19/11/2022		**TLM1**	
No. of classes required to complete UNIT-V		12	No. of classes taken:			

Teaching Learning Methods					
TLM1	Chalk and Talk	**TLM4**	Problem Solving	**TLM7**	Seminars or GD
TLM2	PPT	**TLM5**	Programming	**TLM8**	Lab Demo
TLM3	Tutorial	**TLM6**	Assignment or Quiz	**TLM9**	Case Study

EVALUATION PROCESS:

Evaluation Task	COs	Marks
Assignment/Quiz – 1	1	A1=5
Assignment/Quiz – 2	2	A2=5
I-Mid Examination	1,2	B1=20
Assignment/Quiz – 3	3	A3=5
Assignment/Quiz – 4	4	A4=5
Assignment/Quiz – 5	5	A5=5
II-Mid Examination	3,4,5	B2=20
Evaluation of Assignment/Quiz Marks: A=(A1+A2+A3+A4+A5)/5	1,2,3,4,5	A=5
Evaluation of Mid Marks: B=75% of Max(B1,B2)+25% of Min(B1,B2)	1,2,3,4,5	B=20
Cumulative Internal Examination : A+B	**1,2,3,4,5**	**A+B=25**
Semester End Examinations	**1,2,3,4,5**	**C=75**
Total Marks: A+B+C	**1,2,3,4,5**	**100**

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified

needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct Investigation of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including predictions and modeling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give andreceive clear instructions.

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PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: To apply the knowledge of Aerodynamics, Propulsion, Aircraft structures and Flight Dynamics in the Aerospace vehicle design

PSO2: To prepare the students to work effectively in Aerospace and Allied Engineering organizations.

Course Instructor	Module Coordinator	HOD
(Ms.M.Bhuvaneshwari)	(Dr.P.Lovaraju)	(Dr.P.Lovaraju)

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L.B.Reddy Nagar, Mylavaram-521230, Krishna Dist, Andhra Pradesh, India

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

COURSE HANDOUT

PART-A

Name of Course Instructor : K. Bhanu
Course Name & Code : SATELLITE TECHNOLOGY - 17EC80
L-T-P Structure : 3-0-0 Credits : 3
Program/Sem/Sec : B.Tech., ASE., VII-Sem., A.Y : 2022-23

PRE-REQUISITE: Basics related to Dynamics, Kinematics, Thermodynamics and Properties of an Ellipse.

COURSE EDUCATIONAL OBJECTIVES (CEOs): This course provides the knowledge on different laws associated with the motion of a satellite. The course gives the knowledge on launching a satellite into orbit with launch vehicles. The course also provides the knowledge on various subsystems, structures, thermal control, and applications of a satellite.

COURSE OUTCOMES (COs): At the end of the course, students are able to

CO 1	**Identify** various applications of satellites, launch vehicles and basic functions of satellite system
CO 2	**Understand** components, characteristics of a power subsystem and various aspects of spacecraft control
CO 3	**Evaluate** the orbital model, parameters related to satellites and the requirements needed for the selection an earth station.
CO 4	**Analyze** the satellite structures, internal and external design issues of a spacecraft.

COURSE ARTICULATION MATRIX (Correlation between COs, POs & PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	-	-	-	-	-	1	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	1	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-	2	2	-	-
CO4	1	3	1	-	-	-	-	-	-	-	-	1	2	-	-

Note: Enter Correlation Levels **1** or **2** or **3**. If there is no correlation, **put '-'**
1- Slight (Low), **2** – Moderate (Medium), **3** - Substantial (High).

TEXT BOOKS:

T1 Timothy Pratt, Charles Bostian, Jeremy Allnutt , "Satellite communications", John Wiley & Sons,2nd edition, 2003.

REFERENCE BOOKS:

R1 M. Richharia, "Satellite Communications Systems: Design principles", BS Publications, 2nd Edition, 2005.

R2 D.C Agarwal , "Satellite communications", Khanna Publications, 5th Edition,2006.

R3 Richard, Filipowsky Eugen 1 Muehllorf, 'Space Communication Systems', Prentice Hall 1995.

PART-B

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: Introduction to Satellite Systems:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Course Objectives	1	12/7/22	2/8/22	TLM2	
2.	Brief introduction about the course and its importance.	1	13/7/22	3/8/22	TLM2	
3.	Need for Space Communications, Definition of a satellite and Orbit.	2	15/7/22, 16/7/22	5/8, 6/8	TLM2	
4.	General Structure of satellite Communication, Types of Spacecraft Orbits	2	19/7/22, 20/7/22	10/8, 12/8	TLM2	
5.	Common satellite applications and missions, Launch Vehicles and Launching of a satellite	2	22/7/22, 23/7/22	16/8, 17/8	TLM2	
6.	Satellite system and their functions-(Structural, thermal, power mechanisms, propulsion, etc)	2	26/7/22, 27/7/22	20/8	TLM2	
No. of classes required to complete UNIT-I: 10				No. of classes taken:		

UNIT-II: Orbital Mechanics:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction and overview of Orbital Mechanics	1	29/7/22	23/8/22	TLM1	
2.	Newton's laws of Force, Fundamentals of Orbital Dynamics-Kepler's laws	2	30/7/22, 2/8/22	24/8/22	TLM2	
3.	Orbital parameters and determination	1	3/8/22	26/8/22	TLM2	
4.	Orbital Perturbations-Need for station keeping	1	5/8/22	29/8/22	TLM1	
5.	GPS systems-Architecture of GPS, Working Principle of GPS	2	6/8/22, 10/8/22	30/8/22	TLM2	
6.	Ground station or Earth station Requirements	1	12/8/22	2/9/22	TLM1	
7.	Problems and Revision N	2	16/8/22, 17/8/22	3/9/22 6/9/22	TLM2	
No. of classes required to complete UNIT-II: 10				No. of classes taken:		

UNIT-III: Power System and Bus Electronics:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction to Power system and Bus electronics	1	20/8/22	27/9/22	TLM2	
2.	Solar Panels: Silicon and Ga-As Cells	1	23/8/22	28/9/22	TLM2	
3.	Power generation capacity, efficiency	1	24/8/22	30/9/22	TLM2	
4.	Space Battery Systems	1	26/8/22	1/10/22	TLM2	
5.	Battery Types, Characteristics , Battery efficiency Parameters	1	27/8/22	11/10/22	TLM2	
6.	Telemetry, Tracking and Command	1	30/8/22	12/10/22	TLM2	

	Control (TT&C) functions					
7.	Telemetry, Tracking and Command Control (TT&C) functions	1	3/9/22	13/10/22	TLM2	
8.	Generally Employed Communication Bands	1	3/9/22	14/10/22	TLM2	
9.	Coding Systems Onboard Computer	1	27/8/22	18/10/22	TLM2	
10.	Ground Checkout Systems	1	28/9/22	19/10/22	TLM2	
11.	Revision	1	30/9/22	21/10/22		
No. of classes required to complete UNIT-III: 11				No. of classes taken:		

UNIT-IV : Spacecraft Control:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction to Spacecraft Control	1	1/10/22	22/10/22	TLM2	
2.	Control Requirements: Attitude Control and station keeping functions, type of control maneuvers	3	7/10/22, 11/10/22	25/10/22	TLM2	
3.	Stabilization Schemes: Spin stabilization	1	13/10/22	26/10/22	TLM2	
4.	gravity gradient method, 3 axis stabilization	1	14/10/22	28/10/22	TLM2	
5.	Commonly Used Control Systems: Mass expulsion systems, Momentum exchange systems	3	15/10/22, 18/10/22	29/10/22, 1/11/22	TLM2	
6.	Gyro and Magnetic Torque sensors, Star and sun sensor, Earth sensor.	3	19/10/22, 21/10/22	2/11/22, 4/11/22	TLM2	
7.	Magnetometers and Inertial Sensors.	1	22/10/22	5/11/22	TLM2	
No. of classes required to complete UNIT-IV: 10				No. of classes taken:		

UNIT-V : Satellite Structures and Thermal Control:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction to Satellite Structures and Thermal Control	1	25/10/22	8/11/22	TLM2	
2.	Satellite mechanical and structural Configuration: Satellite Configuration choices, Launch loads, Separation induced loads, Deployment requirements	3	26/10/22, 28/10/22, 29/10/22	9/11/22, 11/11/22, 12/11/22	TLM2	
3.	Design and Analysis of Satellite Structures, Structural materials and Fabrication	2	1/11/22, 2/11/22	15/11/22	TLM2	
4.	The Need of Thermal Control Internally and externally induced thermal control	1	4/11/22	18/11/22	TLM2	
5.	Heat Transfer Mechanism: Internal and External to the Spacecraft	1	5/11/22	19/11/22	TLM2	
6.	Thermal Control Systems: Active method and Passive method	2	9/11/22, 11/11/22	19/11/22	TLM2	
No. of classes required to complete UNIT-V: 10				No. of classes taken:		

Teaching Learning Methods			
TLM1	Chalk and Talk	TLM4	Demonstration (Lab/Field Visit)

TLM2	PPT	TLM5	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	TLM6	Group Discussion/Project

PART-C

EVALUATION PROCESS (R17 Regulations):

Evaluation Task	Marks
Assignment-I (Unit-I)	A1=5
Assignment-II (Unit-II)	A2=5
I-Mid Examination (Units-I & II)	M1=20
I-Quiz Examination (Units-I & II)	Q1=10
Assignment-III (Unit-III)	A3=5
Assignment-IV (Unit-IV)	A4=5
Assignment-V (Unit-V)	A5=5
II-Mid Examination (Units-III, IV & V)	M2=20
II-Quiz Examination (Units-III, IV & V)	Q2=10
Attendance	B=5
Assignment Marks = Best Four Avefage of A1, A2, A3, A4, A5	A=5
Mid Marks =75% of Max(M1,M2)+25% of Min(M1,M2)	M=20
Quiz Marks =75% of Max(Q1,Q2)+25% of Min(Q1,Q2)	B=10
Cumulative Internal Examination (CIE) : A+B+M+Q	40
Semester End Examination (SEE)	60
Total Marks = CIE + SEE	100

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1	**Communication:** Design and develop modern communication technologies for building the inter disciplinary skills to meet current and future needs of industry.
PSO 2	**VLSI and Embedded Systems:** Design and Analyze Analog and Digital Electronic Circuits or systems and Implement real time applications in the field of VLSI and Embedded Systems using relevant tools
PSO 3	**Signal Processing:** Apply the Signal processing techniques to synthesize and realize the issues related to real time applications

Course Instructor	Course Coordinator	Module Coordinator	HOD
Mr. K. Bhanu	Mr. P. James Vijay	Dr. M. V. Sudhakar	Dr. Y. Amar Babu

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Accredited by NAAC with 'A' grade, An ISO 9001:2015 Certified Institution
DEPARTMENT OF AEROSPACE ENGINEERING
Website: https://www.lbrce.ac.in/ase/index.php Email: hodaero@lbrce.ac.in Phone:08659-222933 Ext:624/623

COURSE HANDOUT
Part-A

COURSE INSTRUCTORS : Mr. Nazumuddin Shaik / Mr.G.V.Surya Narayana.

COURSE NAME & CODE : Aircraft Component Modeling and Analysis-17AE66

L-T-P STRUCTURE **:** 0-0-2 **COURSE CREDITS :** 1

PROGRAM **:** B.Tech. VII-Sem. **ACADEMIC YEAR :** 2022-23

COURSE COORDINATOR: Mr.S. Indrasena Reddy

PRE-REQUISITE: Engineering Graphics, Computer Aided Machine Drawing

COURSE EDUCATIONAL OBJECTIVES (CEOs):

The main objective of this course is to learn surface modeling package (CATIA) to draw 2D sketches, 3D parts, various aircraft components and assembly drawing and finite element package (ANSYS) to analyze the behavior of simple structural elements under static loading system.

COURSE OUTCOMES (COs)

At the end of the semester, the student will be able

CO1: Draw aircraft components in 2D and 3D geometric modeling (Apply-L3)

CO2: Solve and analyze the structural components of aircraft for deformations and stresses using a numerical tool. (Analyze-L4)

COURSE ARTICULATION MATRIX (Correlation between COs& POs, PSOs):

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	3	2	3	-	-	-	-	-	-	2	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	3	3	3

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**

1- Slight(Low), **2 -** Moderate(Medium), **3 -** Substantial (High).

Part-B

COURSE DELIVERY PLAN (LESSON PLAN):

S.No	Tentative Date of Completion	Actual Date of Completion	17AE66 - AIRCRAFT COMPONENT MODELING AND ANALYSIS(ACMA) LAB		Learning Outcome COs	HOD Sign Weekly
			List of Experiments			
1	04-08-2022		ACMA Introduction-CATIA Introduction		CO1	
2	11-08-2022		Exp-1	Aircraft Component Design-I	CO1	
3	18-08-2022		Exp-2	Aircraft Component Design-II	CO1	
4	25-08-2022		Exp-3	Aircraft Component Design-III	CO1	
5	01-09-2022		Exp-4	Aircraft Component Design-IV	CO1	
6	29-09-2022		Exp-5	Assembly of Components	CO1	
7	13-10-2022		Exp-6	Static analysis on beam	CO2	
8	20-10-2022		Exp-7	Eigenvalue Buckling analysis	CO2	
9	27-10-2022		Exp-8	Model analysis on Wing	CO2	
10	03-11-2022		Exp-9	Thermal analysis	CO2	
11	10-11-2022		Exp-10	Static analysis of composite laminate	CO2	

Contents beyond the Syllabus:

12			Exp-11	Aircraft components assembly and analysis	CO1 & CO2

Part - C

EVALUATION PROCESS (R17 Regulations) :

Parameter		Marks
Day – to – Day Work	Observation	A1 = 10 Marks
	Record	A2 = 10 Marks
Internal Test		B =10 Marks
Attendance		C = 05 Marks
Viva – Voce During Regular Lab Sessions		D = 05 Marks
Cumulative Internal Examination		**A1+ A2 + B+C+D = 40 Marks**
Semester End Examinations		**E = 60 Marks**
Total Marks: A1+ A2 + B + C + D + E		**100 Marks**

Part - D

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Program Educational Objectives (PEO)

PEO1: To provide students with sound mathematical, engineering and multidisciplinary knowledge to solve Aerospace and Allied Engineering problems.

PEO2: To prepare students to excel in higher education programs and to succeed in industry/academia profession.

PEO3: To inculcate ethical attitude, leadership qualities, problem solving abilities and life-long learning for a successful professional career.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct Investigation of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including predictions and modeling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: To apply the knowledge of Aerodynamics, Propulsion, Aircraft structures and Flight Dynamics in the Aerospace vehicle design

PSO2: To prepare the students to work effectively in Aerospace and Allied Engineering organizations

Mr. Nazumuddin Shaik	Dr.Prabhu L	Dr.P.Lovaraju
Course Instructor	Module Coordinator	HOD