Department of Mechanical Engineering

M.Tech. Thermal Engineering
Curriculum and Syllabus

(Applicable to the students admitted from AY: 2023 onwards)

School of Engineering and Sciences
SRM University *AP*, Andhra Pradesh

Department Vision

To become distinct and renowned globally by graduating high-quality professionals through rigorous coursework and cutting-edge research.

Department Mission

1. Emerge as a world class mechanical engineering department in exploring and providing knowledge through high quality academic programs and experiential learning.
2. Create an ambience for impactful research aligning to the national mission and addressing the societal needs.
3. Create entrepreneurs and leaders of the future imparted with knowledge, global awareness, and strategic thinking.
4. Promote high standards of integrity, and ethical behaviour among faculty members, staff, and students.

Program Educational Objectives (PEO)

1. Prepare graduates with sound fundamental knowledge and advanced research knowledge in the field of thermal engineering especially in the field of electronic cooling and to make them capable of effectively analyzing and solving the problems associated with cooling challenges of electronic components.
2. Prepare the graduates with core competency to be successful in industry or academia or research laboratories with a strong understanding and ability to analyze problems, understand the technical requirements, design, create and deliver effective engineering solutions.
3. Prepare graduates to Inculcate Teamwork, Communication and Interpersonal Skills adapting to Changing Environments of Technology, leadership qualities, professional and ethical values.
4. Prepare graduates for excellent careers in Thermal Engineering with specialization in electronic cooling or related fields by utilizing their knowledge and contributing as exceptional professionals, as well as encouraging a sense of entrepreneurship

Mission of the Department to Program Educational Objectives (PEO) Mapping

	PEO 1	PEO 2	PEO 3	PEO 4
Mission Statement 1	3	2	3	2
Mission Statement 2	3	3	3	2
Mission Statement 3	2	1	3	3
Mission Statement 4	3	2	2	3

Program Specific Outcomes (PSO)

1. Apply knowledge of maths, science, and engineering with a multidisciplinary approach to identify, formulate, and solve the problems facing the electronic cooling industry to realize its hardware design potential.
2. Ability to perform research with the application of advanced knowledge in thermal management of electronic components to develop novel cooling solutions which address the cooling challenges of electronic components.
3. Work effectively in a team to design components, systems, and processes to meet desired goals within realistic economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability constraints using advanced digital/simulation tools like ANSYS ICEPAK.

Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)													
PEOs	POs										PSOs		
	Engineering Knowledge	Design Development of Solutions	Conduct Investigations of Complex Problems	Modern Tools and ICT Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork Skills	Communication Skills	Lifelong Learning	PSO 1	PSO 2	PSO 3
PEO 1	3	3	3	3	2	2	3	2	2	2	3	3	2
PEO 2	3	3	3	3	3	2	3	1	2	2	3	3	3
PEO 3	3	3	3	3	2	3	3	3	3	3	2	2	3
PEO 4	3	3	2	3	2	3	3	1	2	2	3	2	2

Category Wise Credit Distribution			
Course Sub-Category	**Sub-Category Credits**	**Category Credits**	**Learning Hours**
Ability Enhancement Courses (AEC)		1	30
University AEC	0		
School AEC	1		
Value Added Courses (VAC)		1	30
University VAC	1		
School VAC	0		
Skill Enhancement Courses (SEC)		4	120
School SEC	4		
Department SEC	0		
SEC Elective	0		
Foundation / Interdisciplinary courses (FIC)		4	120
School FIC	4		
Department FIC	0		
Core + Core Elective including Specialization (CC)		35	1050
Core	27		
Core Elective (Inc Specialization)	8		
Minor (MC) + Open Elective (OE)	0	0	0
Research / Design / Internship/ Project (RDIP)		35	1050
Internship / Design Project / Startup / NGO	3		
Internship / Research / Thesis	32		
Total		**80**	**2430**

Semester wise Course Credit Distribution Under Various Categories						
Category	**Semester**					
	I	**II**	**III**	**IV**	**Total**	**%**
Ability Enhancement Courses - AEC	0	1	0	0	1	**1**
Value Added Courses - VAC	0	1	0	0	1	**1**
Skill Enhancement Courses - SEC	2	2	0	0	4	**5**
Foundation / Interdisciplinary Courses - FIC	4	0	0	0	4	**5**
CC / SE / CE / TE / DE / HSS	15	20	0	0	35	**44**
Minor / Open Elective - OE	0	0	0	0	0	**0**
(Research/ Design/ Industrial Practice/Project/Thesis/Internship) -RDIP	0	3	17	15	35	**44**
Grand Total	**21**	**27**	**17**	**15**	**80**	**100**

Note: L-T/D-P/Pr and the class allocation is as follows.

a) Learning Hours : 30 learning hours are equal to 1 credit.

b) Lecture/Tutorial : 15 contact hours (60 minutes each) per semester are equal to 1 credit.

c) Discussion : 30 contact hours (60 minutes each) per semester are equal to 1 credit.

d) Practical : 30 contact hours (60 minutes each) per semester are equal to 1 credit.

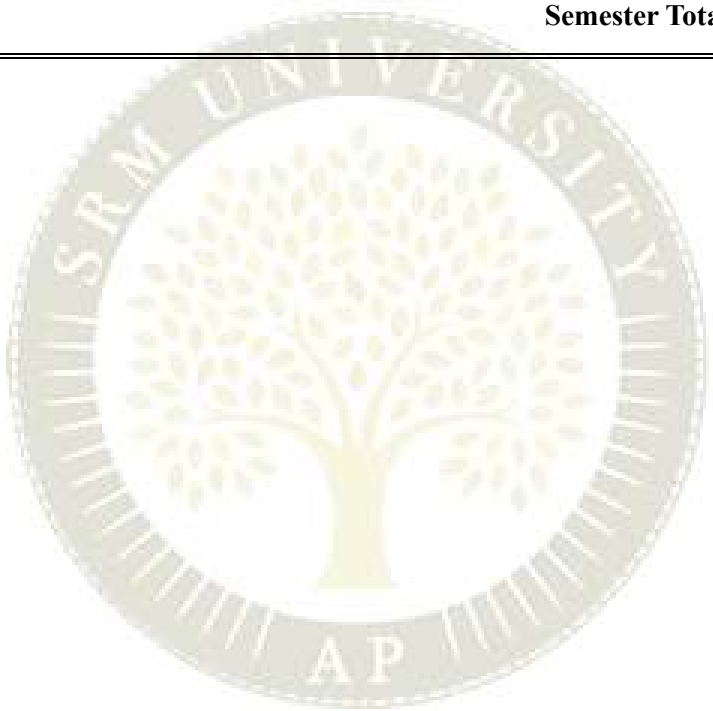
e) Project : 30 project hours (60 minutes each) per semester are equal to 1 credit.

SEMESTER - I								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 501	Community Engagement and Social Responsibility	0	0	1	1*
2	VAC	S AEC	AEC 502	Research Seminar - I	0	0	1	1*
3	SEC	S SEC	SEC 502	Design Thinking	1	0	1	2
4	FIC	D FIC	FIC 505	Advanced Numerical Techniques	2	1	1	4
5	Core	CC	THE 501	Practical CFD and HT	2	1	1	4
6	Core	CC	THE 502	Thermal Measurements in Industries	2	1	0	3
7	Core	CC	THE 503	Advanced Fluid Dynamics	2	1	1	4
8	Core	CC	THE 504	Industrial Heat and Mass Transfer	2	1	1	4
				Semester Total	**11**	**5**	**7**	**22**

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 502	Community Engagement and Social Responsibility	0	0	1	1
2	AEC	S AEC	AEC 503	Research Seminar	0	0	1	1
3	SEC	S SEC	SEC 103	Entrepreneurial Mindset	1	0	1	2
4	CC	Core	THE 505	Thermal Design of Electronics Equipment	2	0	1	4
5	CC	Core	THE 506	Micro and Nanoscale Heat Transfer	3	0	1	4
6	CC	Core	THE 507	Computational Techniques for Electronic Cooling	1	1	2	4
7	CE	CE	CE	Core Elective	2	1	1	4
8	CE	CE	CE	Core Elective	2	0	1	4
9	RDIP	RDIP	THE 508	Project Management	0	0	3	3
				Semester Total	**11**	**2**	**12**	**27**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	THE 509	Thesis - I	0	0	14	14
2	RDIP	RDIP	THE 510	Industrial Practice	0	0	3	3
				Semester Total	**0**	**0**	**17**	**17**

SEMESTER - IV								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	THE 511	Thesis -II	0	0	15	15
				Semester Total	**0**	**0**	**15**	**15**



Core Electives								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	THE 530	Introduction to Multiphase flows	2	1	1	4
2	Elective	CE	THE 531	Design of Heat Exchange equipment	2	1	1	4
3	Elective	CE		Turbulence and Shear Flows	2	1	1	4
4	Elective	CE		Transport in Porous Media	2	1	1	4

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Research Seminar

Course Code	AEC 502	Course Category		L	T	P	C
				0	0	1	1
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To learn how to write the seminars in an effective way
2. To learn what are the skills needed for presentation of science
3. To learn effective science communication.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the features and characteristics seminars and presentations.	2	80%	80%
Outcome 2	Discuss methods of the presentation.	2	65%	60%
Outcome 3	Explain the parameters of conducting seminars.	3	65%	60%
Outcome 4	Discuss the responses to Q&A sessions in seminars.	2	60%	65%
Outcome 5	Explain conflict management during presentations and seminars.	3	80%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2		2	3	2	1			3	3	2	3	1	2	2
Outcome 2	2		2	3	2	1			3	3	2	3	2	2	1
Outcome 3	2		2	3	2	1			3	3	2	3	2	2	1
Outcome 4	2		2	3	2	1			3	3	2	3	2	2	1
Course Average	**2**		**2**	**3**	**2**	**3**		**3**	**3**	**3**	**2**	**3**	**2**	**2**	**1**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Explanation on what is a seminar and what are expected during the seminar, followed by student presentations	**5**	1,3	1,2
Unit No. 2	Discussion on tools for effective presentation	**7**	1, 2	3,4,5
Unit No. 3	Discussion and presentation demonstration	**8**	3	5
Unit No. 4	How to answer the questions during the presentation. Student presentation and discussion	**5**	4,5	6
Unit No. 5	How to manage the conflicts during the presentation	**5**	1, 4, 5	6

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)	
		Report (20%)		Mid-Review (30%)			
		Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		60%		30%	
	Understand						
Level 2	Apply	60%		40%		70%	
	Analyse						
Level 3	Evaluate						
	Create						
Total		**100%**		**100%**		**100%**	

Recommended Resources

1. Brian Tracy, Speak to Win: How to Present with Power in Any Situation, Kindle Edition
2. Robert RH Anholt, Dazzle 'Em With Style: The Art of Oral Scientific Presentation, (ISBN: 0123694523)
3. Vernon Booth, Communicating in Science: Writing a Scientific Paper and Speaking at Scientific Meetings (ISBN: 0521429153)
4. Matt Carter Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More (ISBN: 0123859697)
5. Garr Reynolds Presentation Zen: Simple Ideas on Presentation Design and Delivery (ISBN: 0321811984)
6. Herbert Fensterheim and Jean Baer, Don't Say Yes When You Want to Say No: Making Life Right When It Feels All Wrong, Mass Market, 1975

Course Designers

1. Dr. Sangjukta Devi, Assistant Professor, Department of Mechanical Engineering, SRM university AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Design Thinking

Course Code	SEC 502	Course Category	SEC	L	T	P	C
				1	0	1	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Management	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Familiarize with the principles of Design Thinking
2. Learn to apply the principles of Design Thinking
3. Apply Design Thinking to solve problems
4. Analyze design thinking for innovation

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Grasp the Concepts and process of Design Thinking	2	85%	90%
Outcome 2	Learn the process of Design Thinking	2	85%	90%
Outcome 3	Solve a problem using Design Thinking Principles	5	75%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)										PSO		
	Engineering Knowledge	Design /Development of solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineering and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication Skills	Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3									1	3	1	3
Outcome 2	3							3		2	3	2	3
Outcome 3	3	3	3	3				3	3	3	3	3	3
Average	3	3	3	3				3	3	2	3	2	3

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Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Incubation and understanding**			1,2
	Understanding of Design Thinking & its Importance	4	1	1,2
	Importance of Design Thinking	3	1	1,2
	Pillars of Design Thinking	3	1	1,2
Unit 2	**Process – Understanding the Stages of Design Thinking**			1,2
	Stage 1- Empathy	2	2	1,2
	Stage 2 - Define	2		
	Stage 3 – Ideate	2		
	Stage 4 – Prototype	2	2	1,2
	Stage 5 – Test & Implement	2	2	1,2
Unit 3	**Application**			
	Project Work	7	3	1,2
	Viva	3	3	1,2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (100%)**	
		CLA-1 (50%)	**CLA-2 (50%)**
Level 1	Remember	20	40
	Understand		
Level 2	Apply	30	30
	Analyse		
Level 3	Evaluate	50	30
	Create		
Total		**100%**	**100%**

Recommended Resources

1. Design Thinking – Techniques and Approaches, N. Siva Prasad

Other Resources

1. HBS – Online – Design Thinking & Innovation – course material
2. Case studies
3. Nigel Cross, (2011) Design Thinking, BERG Publishing.
4. Thomas Lockwood, Design Thinking- Integrating Innovation, Customer Experience and Brand Value (2009), Design Management Institute,

Course Designers

1. Satyanarayana Duvvuri, Visiting Faculty, Paari school of business, SRM University AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

ADVANCED NUMERICAL TECHNIQUES

Course Code	FIC 505	Course Category	Core	L	T	P	C
				2	1	1	4
Pre-Requisite Course(s)	Linear Algebra Calculus	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand and derive the solution methodologies
2. Understand the advantages and disadvantages of various numerical methods to solve a particular problem
3. Gain knowledge of the methods to the engineering applications
4. Learn the computational implementation of the methods

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Classify the numerical methods	2	80%	75%
Outcome 2	Solve given engineering problems based on numerical methods such as Gauss elimination, bisection, least squares regression and differential equations	3	75%	65%
Outcome 3	Solve given engineering problems using numerical techniques and MATLAB	3	70%	65%
Outcome 4	Demonstrate index notation methods for given equations using MATLAB	3	60%	55%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)												
	Engineering Knowledge	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	**2**	**2**	**2**	**2**	-	-	**2**	**-**	3	3	2	3
Outcome 2	3	**3**	**2**	**3**	**3**	-	**-**	**2**	**-**	3	3	3	3
Outcome 3	3	**3**	**3**	**3**	**3**	-	**-**	**3**	**-**	3	3	2	3
Outcome 4	2	**3**	**2**	**3**	**3**	-	**-**	**2**	**-**	3	3	3	3
Course Average	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**2**	**-**	**3**	3	3	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction to Numerical Techniques	2	1	1,3
	Scientific notation, Precision effects,	1		
	Accuracy, Error's Syntax	1		
Unit No. 2	Gauss elimination method	2	2	1,2
	LU decomposition, Tri diagonal Matrices, Thomas algorithm	3		
	Iterative methods (Jacobi, Gauss-Siedel)	2		
	Nonlinear equations solution using Bisection and Newton Raphson Nonlinear systems	3		
Unit No. 3	Linear, quadratic and cubic interpolation -- Direct methods	2	2	1,2,3
	Newton divided differences interpolation	2		
	Lagrange interpolation	1		
	Curve fitting and its applications	1		
	Regression analysis, error definitions	1		
	Linear least squares regression single variable, multi variable	1		
	Polynomial regression	2		
Unit No. 4	Ordinary differential equations integration using Euler and Runge Kutta methods	2	3,4	1,2
	Ordinary differential equations Predictor corrector methods, boundary and initial value problems	3		
	Discretisation, grid and boundaries	2		
	Finite differences (forward, backward and central) formulas upto 6th order derivations	3		
	Order of accuracy	2		
	Classification of partial differential equations (PDE)	1		
	Solution of elliptic, hyperbolic and parabolic PDE using finite differences	2		
Unit No. 5	Application of linear and nonlinear system solutions to various engineering problems	1.5	4	1,2
	Application of Curve fitting and interpolation in Mechanical engineering	1.5		
	ODE and PDE applications specific to mechanical engineering	3		

Exp No	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Introduction to MATLAB Programming	2	1	1, 2
2	Solution of linear algebraic equations using direct methods	4	3,4	1, 2
3	Linear algebraic equations using iterative methods	4	3,4	1, 2
4	Nonlinear equations, using Newton Raphson and Bisection	4	3,4	1, 2
5	Regression implementation	6	3,4	1, 2
6	Euler, Runge Kutta 2nd and fourth order methods	4	3,4	1, 2
7	Finite differences	2	3,4	1, 2
8	Partial differential equations	4	3,4	1, 2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)					End Semester Exam (40%)	
		CLA-1 (10%)	Mid Term (10%)	CLA-2 (10%)	CLA-3 (10%)	Prac (20%)		
		Th	Th	Th	Th	Prac	Th (20%)	Prac (20%)
Level 1	Remember	30%	40%	20%	20%	20%	30%	
	Understand							
Level 2	Apply	70%	60%	60%	60%	60%	70%	
	Analyse							
Level 3	Evaluate	-	-	20%	20%	20%	-	
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	

Recommended Resources

1. Canale, Raymond P., and Steven C. Chapra. Numerical methods for engineers. Mcgraw-hill Education-Europe, 2014.
2. Numerical Methods using MATLAB, John H Mathews.
3. Numerical Methods with worked examples, Chris H. Woodford and Christopher Phillips, Springer

Other Resources

1. https://in.mathworks.com/help/matlab/getting-started-with-matlab.html
2. https://www.math.hkust.edu.hk/~machas/numerical-methods.pdf
3. https://ocw.mit.edu/courses/18-335j-introduction-to-numerical-methods-spring-2019

Course Designers

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Practical Computational Fluid Dynamics and Heat Transfer

Course Code	THE 501	**Course Category**	CC	**L**	**T**	**P**	**C**
				2	1	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Use numerical methods for solving various fluid flow and heat transfer problems.
2. Enhanced knowledge on application of computational methods for modelling fluid flow and heat transfer problems.
3. To be able to formulate steady and unsteady Finite-Difference & Finite-Volume numerical methods and understand the solution algorithms.
4. To be able to simulate practical CFD problems on fluid flow and heat transfer.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Recognize the importance of CFD in Heat and Fluid flow problems	3	70%	65%
Outcome 2	Employ higher order upwind schemes to solve given fluid flow and heat transfer problems.	3	70%	65%
Outcome 3	Employ finite volume discretization techniques to solve given engineered problems related to heat conduction and convection problems.	4	70%	65%
Outcome 4	Investigate how to handle power law of fluids in CFD for solving Fluid flow and heat transfer problems.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**												
	Engineering Knowledge	**Design and Development of solutions**	**Conduct Investigation of Complex problems**	**Modern Tool Usage**	**The Engineer and Society**	**Environment and Sustainability**	**Ethics**	**Individual and Teamwork**	**Communications**	**Lifelong learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	3	2	2	3	1	-	2	1	3	3	2	2
Outcome 2	3	3	3	3	3	2	-	2	1	3	3	2	2
Outcome 3	3	3	3	3	3	2	-	2	1	3	3	2	2
Outcome 4	3	3	3	3	3	2	-	2	1	3	3	2	2
Course Average	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**2**	**1**	**3**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction about the Course	2	1	2,4
	Finite Difference Method (preliminaries)	3	2,3,4	2,4
	Explicit, Implicit, ADI Formulation, Stability Analysis	3	2,3,4	3,4
	Conservative and Transportive Properties	2	1,2,3	2,3,4
	Numerical problems	2	2,3,4	2,3,4
Unit No. 2	Upwinding, Artificial Viscosity, Second Upwind	3	2,3,4	2, 3
	Higher order Up winding	2	2,3,4	3,4
	Important Issues of higher order Upwinding	3	2,3,4	4
	Numerical problems	2	1,2,4	2, 3
Unit No. 3	Introducing finite volume method for discretizing the differential equation	3	2,3,4	1, 2, 3
	Conduction: Steady one-dimensional conduction, Unsteady one-dimensional conduction, Two- and three-dimensional situations, overrelaxation and under relaxation	3	2,3,4	1, 2, 3
	Diffusion: The finite volume method for one-, two- and three-dimensional diffusion problems	3	2,3,4	1, 2, 3
	Numerical problems	3	1,2,3,4	1,2,3
Unit No. 4	Steady one-dimensional convection and diffusion.	3	2,3,4	1, 2, 4
	The power law schemes: Higher order differencing schemes for convection-diffusion problems.	3	1,2,3,4	1, 2, 4
	TVD Schemes.	2	1,2,3,4	1, 2,4
	Numerical problems	2	1, 2,3,4	1, 2, 4
Total Contact Hours		45		

Course Unitization Plan-Practical

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Practicing the modelling of a given geometry using CAD	4	1,2	5
2.	Flow through inside pipe in 3D	4	1,2,3,4	5
3.	Flow over the car to find Drag in 2D	2	1,2	5
4.	Couette flow in flat pipe in 3D	4	1,2,3	5
5.	Flow through the bend pipe in 3D	4	1,2,3	5
6.	A project on "Simulation of fluid flow and heat transfer through exhaust manifold"	12	1,2	1,2,3,4
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (10%)		Th	Prac
Level 1	Remember	20%	10%	10%	10%	20%	20%	20%
	Understand							
Level 2	Apply	80%	90%	90%	90%	80%	80%	80%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. An Introduction to Computational Fluid Dynamics THE FINITE VOLUME METHOD, Second Edition, H. K. Versteeg and W. Malalasekera, Pearsons.
2. Numerical Heat transfer and fluid flow, Suhas V. Patankar. McGraw-Hill Book Company.
3. Computational Fluid Dynamics, An Open-Source Approach. Brian C. Vermeire, Carlos A. Pereira and Hamidreza Karbasian.
4. Computational Fluid Dynamics: The Basics with Applications, John D Anderson Jr. McGraw-Hill publications.
5. Practical CFD & HT manual, SRM University AP.

Course Designers

1. Dr. Lakshmi Sirisha Maganti and Dr. Surfarazhussain S. Halkarni, Assistant Professor, Department of Mechanical Engineering, SRM University-AP, Andhra Pradesh.

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Thermal Measurements in Industries

Course Code	THE 502	**Course Category**	CC			**L**	**T**	**P**	**C**
						2	1	0	3
Pre-Requisite Course(s)	Fluid Mechanics, Heat transfer, Calculus	**Co-Requisite Course(s)**		**Progressive Course(s)**					
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**							

Course Objectives / Course Learning Rationales (CLRs)

1. To enhance the understanding of measurement systems, mathematical modelling and system responses both static and dynamic behaviour.
2. To have an improved understanding of measurement errors, statistical data analysis and their interpretation.
3. To learn different techniques of instrumentation involved in measurement of thermal quantities.
4. To provide understanding and exposure in planning of experimental work and choice of instrumentation in realistic engineering problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Identify the various measurement systems and their modelling in real life situations.	2	70%	80%
Outcome 2	Apply the in depth understanding of errors in measurements and statistical analysis.	3	70%	80%
Outcome 3	Identify and interpret the measurements process for pressure, flow and temperature in real life.	4	70%	80%
Outcome 4	Analyse measured and acquired data for different measurement processes for given applications.	4	70%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**										-		
	Engineering Knowledge	**Design / Development of Solutions**	**Conduct Investigations of Complex Problems**	**Modern Tool Usage**	**The Engineer and Society**	**Environment and Sustainability**	**Ethics**	**Individual and Team Work**	**Communication**	**Life-long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	2	2	2	2	-	-	2	-	2	3	2	2
Outcome 2	3	3	2	3	3	-	-	3	-	3	2	3	2
Outcome 3	3	3	3	3	3	-	-	3	-	3	2	3	3
Outcome 4	2	3	2	3	3	-	-	3	-	3	3	3	3
Course Average	**3**	**3**	**2**	**3**	**3**	-	-	**3**	-	**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Methodology and planning of experimental work	1	1	1, 3, 4, 5
	Introduction to measurements, Measurement categories-primary and derived quantities, intrusive and non-intrusive methods	2.0	1	1, 3, 4, 5
	Static and dynamic characteristics	1.5	1, 4	1, 3, 4, 5
	System response- first and second order systems and analysis	1.5	1, 4	1, 3, 4, 5
Unit No. 2	Analysis of experimental data- types of errors Uncertainty analysis, propagation of uncertainty	3	2	2, 3, 4
	Statistical analysis of experimental data- normal error distributions (confidence interval and level of significance, Chauvenet's criterion)	3	2	2, 3, 4
	Chi-square test of goodness of fit, method of least squares (regression analysis, correlation coefficient),	2	2	2, 3, 4
	Multivariable regression, Students' t-distribution, graphical analysis and curve fitting.	2	2	2, 3, 4
Unit No. 3	Measurement of temperature- thermoelectric thermometry, resistance thermometry, pyrometry	04	3	1, 3, 5
	Liquid in glass, bimetallic and liquid crystal thermometer	02	3	1, 3, 5
	Temperature sensors for measurement of transient temperature.	02	3	1, 3, 5
	Measurement of pressure-U-tube manometer, Bourdon gage, pressure transducers,	04	3	1, 3, 5
Unit No. 4	Measurement of transient and vacuum pressures	02	3	1, 3, 5
	Measurement of volume flow rate- variable area type flow meter-orifice plate meter, flow nozzle, venture meter, rotameter	04	3, 4	1, 2, 5
	Measurement of velocity-Pitot static and impact probes	03	3, 4	1, 2, 5
	Velocity measurement based on thermal effect	01	3, 4	1, 2, 5
Unit No. 5	Doppler velocimetry, Time of flight velocimetry	03	3, 4	1, 2, 5
	Analog to digital conversion Fourier series and transform, sampling, aliasing, and filtering	2.5	3, 4	1, 2, 3
	Cross-correlation and autocorrelation. Digital image analysis.	1.5	3, 4	1, 2, 3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (05%)		Mid Term (25%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	30	-	20	-	20	-	30	-	30	-
	Understand										
Level 2	Apply	60	-	70	-	70	-	70	-	70	-
	Analyse										
Level 3	Evaluate	10	-	10	-	10	-	-	-	-	-
	Create										
Total		**100%**	**-**	**100%**	**-**	**100%**	**-**	**100%**	**-**	**100%**	**-**

Recommended Resources

1. S. P. Venkateshan, Mechanical Measurements, Anne Books Pvt. Ltd., 2015
2. J. P. Holman, Experimental Methods for Engineers, McGraw-Hill, 2011
3. Ernest O. Doeblin and Dhanesh N. Manik, Measurement and Systems: Application and Design, 6th edition, McGraw-Hill, 2011
4. John R. Taylor, An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements, University Science Books, 1997
5. Thomas G. Beckwith and Roy D. Marangoni, Mechanical Measurements, Pearson, 6th edition, 2007.

Other Resources

1. Fourier Series & Transforms: https://www.youtube.com/watch?v=mgXSevZmjPc.

Course Designers

SRM University *AP*, Andhra Pradesh
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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Advanced Fluid Dynamics

Course Code	THE 503	**Course Category**	CC		**L**	**T**	**P**	**C**
					2	1	1	4
Pre-Requisite Course(s)	Basic Fluid Mechanic Course	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Enhanced understanding on fluid dynamics to analyze practical fluid flow problems by applying advanced solutions of fluid mechanics and to Interpret and apply exact solutions of the Navier- Stokes equation to practical problems.
2. To impart knowledge on low velocity flows-Stokesian flows.
3. To Understand and apply Boundary layer theory to engineering problems in case of both external flows and internal flows.
4. To impart knowledge on the origin and nature of turbulence.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Solve and evaluate fluid velocity in the flow field and compute the rate of deformation of the fluid element.	2	70%	65%
Outcome 2	Employ Navier Stokes Equation to solve real time engineering problems of high, low reynolds number flows and boundary layer flows.	3	70%	65%
Outcome 3	Calculate the total drag and lift forces associated with structures immersed in the fluid and computing the flow rate and pumping power of the fluid.	4	70%	65%
Outcome 4	Predict the length scale of eddies and Reynolds stress.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)												
	Engineering Knowledge	Design and Development of solutions	Conduct Investigation of Complex problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communications	Lifelong learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	2	1	-	2	1	3	3	2	2
Outcome 2	3	3	3	3	3	1	-	2	1	3	3	2	2
Outcome 3	3	3	3	3	3	2	-	2	1	3	3	2	3
Outcome 4	3	3	3	3	3	2	-	2	1	3	3	3	2
Course Average	**3**	**3**	**3**	**3**	**3**	**1**	**-**	**2**	**1**	**3**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Properties of fluid, application of fluid mechanics and introduction to fluid statics.	2	1	2,4
	Introduction to basic principles such as Eulerian and Lagrangian approaches	2	1	2,4
	Types of flows, characterisation of fluid flows by covering the topic of streamline, path line and streak line also the concept of acceleration.	3	1	2,4
	Deformation of fluid elements and the concept of conservation of mass and various non dimensional numbers & Numerical problems	3	1	2,5
Unit No. 2	Introduction to Euler equations and Bernoulli equations.	2	1,2	1, 3, 4
	Navier-Stokes equations	3	1,2	1, 3, 4
	Application of simplified Navier-stokes equations for Parallel flows, Couette flow, Plane Poiseuille flow, Hagen-Poiseuille flow, flow in a convergent-divergent channel	3	1,2	1, 3, 4
	Low Reynolds number flows Stokes's first problem and second problem. Numerical problems	4	1,2	1, 3, 4
Unit No. 3	Boundary layer formation in case both internal flows and external flows	3	2,3	1, 3
	Non-dimensional form of the Navier-Stokes equations, the concept of order of magnitude analysis	2	2,3	1, 3
	Displacement and momentum thickness for external flow	2	2,3	1, 3
	Exact solutions of boundary layer equations for a flat plate & Numerical problem	3	2,3	1, 3
Unit No. 4	The concept of boundary layer separation	2	2,3,4	1, 2, 3,4
	Potential flows, the concept of lift and drag and its applications	2	2,3,4	1, 2, 3, 4
	Compressible flows and significance of Mach number & Numerical problems.	3	2,3,4	1, 2, 3,4
Unit No. 5	Introduction to turbulent flows, eddy’s formation, statistical description of turbulent flows	3	4	1, 3,4
	Introduction to Reynolds stresses.	3	4	1, 3,4
Total Contact Hours		**45**		

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Practising the modelling of a given geometry using CAD	2	1,2,3,4	5
2.	Practising the modelling and analysis using ANSYS-2D	4	1,2,3,4	5
3.	Practising the modelling and analysis using ANSYS-3D	4	1,2,3,4	5
4.	Flow through a pipe simulation in 3D	4	1,2,3,4	5
5.	Couette flow in the parallel plate in 3D	4	1,2,3,4	5
6.	Capturing the boundary layer on the flat plate	4	1,2,3,4	5
7.	Flow through bend pipe in 3D	4	1,2,3,4	5
8.	Flow over a cylinder	4	1,2,3,4	5
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (10%)		Th	Prac
Level 1	Remember	30%	20%	20%	10%	20%	25%	20%
	Understand							
Level 2	Apply	70%	80%	80%	90%	80%	75%	80%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. K Muralidhar and G Biswas, "Advanced Engineering Fluid Mechanics", 3/e,Narosa Publishing House.,2001.
2. Yunus A Cengel& John Cimbala, "Fluid Mechanics: Fundamentals and Applications", 3/e McGraw Hill., 2017.
3. Ronald L. Panton, "Incompressible Flow", 4/e, John Wiley & Sons Inc., 2011.
4. Robert W. Fox, Alan T. McDonald, &Philip J., "Fluid Mechanics", 8/e, John Wiley & Sons Inc., 2017.
5. Lab manual, SRM University AP.

Course Designers

1. Dr. Lakshmi Sirisha Maganti, Assistant Professor, Department of Mechanical Engineering, SRM University-AP, Andhra Pradesh.

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Industrial Heat and Mass Transfer

Course Code	THE 504	**Course Category**	CC			**L**	**T**	**P**	**C**
						2	1	1	4
Pre-Requisite Course(s)	Fluid Mechanics, Heat Transfer, Thermodynamics, Calculus	**Co-Requisite Course(s)**		**Progressive Course(s)**					
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**							

Course Objectives / Course Learning Rationales (CLRs)

1. To enhance the understanding of heat transfer processes and their relevance to industrial problems.
2. To understand the derivations and physical meaning of governing equations of energy transfer.
3. To strengthen analytical and numerical abilities to solve complex heat transfer problems.
4. To provide experience in treating multimode heat transfer effects and in solving realistic engineering problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Identify the various heat transfer phenomena in real life situations.	2	70%	80%
Outcome 2	Apply the in depth understanding of conduction, convection and phase change processes of energy transfer.	3	70%	80%
Outcome 3	Interpret and solve the complex heat transfer problems and be able to compute their contributions to the energy exchange process.	4	70%	80%
Outcome 4	Analyse multi-mode heat transfer effects and situations for given applications	4	70%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**										-		
	Engineering Knowledge	Design / Development of	Conduct Investigations of	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Team Work	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	2	-	-	2	-	2	3	2	2
Outcome 2	3	3	2	3	3	-	-	3	-	3	2	3	2
Outcome 3	3	3	3	3	3	-	-	3	-	3	2	3	3
Outcome 4	2	3	2	3	3	-	-	3	-	3	3	3	3
Course Average	**3**	**3**	**2**	**3**	**3**	-	-	**3**	-	**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Review of Heat Transfer Fundamentals: Brief review of Conduction: Transient conduction and extended surface	1.5	1	1, 6, 8
	Steady Laminar and Turbulent Heat Transfer in External and Internal Flows, Free and Forced convection	2.0	1	4, 5, 6, 8
	Brief review of radiation basics and mass transfer, Heat conduction - basic law,	0.5	1	1, 2, 6, 8
	governing equations in differential form including enthalpy basis, solution methods	3	2, 4	6, 7, 8, 12
Unit No. 2	Steady state conduction , Unsteady state problems-fins and moving fins problem	2.5	1, 2, 4	6, 7, 8, 12
	Moving boundaries/ interface problems in heat transfer Convective heat transfer	3.5	1, 2, 4	8, 12
	Conservation equations, boundary layer approximations Forced convective laminar and turbulent flow solutions.	03	2, 3	3, 4, 5, 6
	Natural convection solutions, correlations. Thermodynamics and physics of phase change	3.5	2, 3	3, 4, 5, 6
Unit No. 3	Vapor-liquid equilibrium for pure and multicomponent miscible fluids. Clasius-Clapeyron equation,	02	2, 3	3, 4, 5, 6
	Young-Laplace equation, capillary and Bond number. Contact angle and its hysteresis,	02	2, 3	3, 4, 5, 6
	Cassie-Baxter equation, surface wettability, super hydrophobic surface	1.5	2, 3	3, 4, 5, 6
	Bubble dynamics-Rayleigh equation, bubble deformation and collapse, breakup and coalescence Pool boiling-Nukiyama curve,	02	2, 3	3, 4, 5, 6
Unit No. 4	Boiling hysteresis, homogeneous and wall nucleation , liquid superheat, bubble departure, release frequency, nucleation site density, heat transfer mechanism, pool boiling correlation-Rohsenow equation, VDI correlation	04	2, 3, 4	3, 4, 5, 6, 8 9
	Effect of system pressure, heater geometry, surface wettability, dissolved gases and liquid sub cooling, boiling	02	2, 3, 4	3, 4, 9, 10, 11
	Critical heat flux in pool boiling-vapor jet Taylor and Kelvin-Helmholtz instability model	01	2, 3, 4	3, 4, 9, 10, 11
	correlation for CHF, film boiling – role of radiation, the Brombley model.	02	2, 3, 4	3, 4, 9, 10, 11
Unit No. 5	Two phase flow and flow boiling – flow maps, homogeneous model, Lockhart-Martinelli and Martinelli- Nelson model, Chisolm Model , drift flux model	03	2, 3, 4	3, 4, 9, 10, 11
	Flow boiling – onset of nucleate boiling, convective boiling, Chen's correlation, subcooled and saturated flow boiling, DNB and dry out, post dry out heat transfer.	02	2, 3, 4	3, 4, 9, 10, 11
	Mass Transfer- governing laws, transfer coefficients; applications	1.5	1, 2, 4	2, 6, 8
	Convective Mass Transfer – Combined Heat and Mass Transfer	2.5	1, 2, 4	2, 6, 8

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (5%)		Mid Term (25%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	30	-	20	-	20	-	40	-	30	-
	Understand										
Level 2	Apply	70	-	70	-	70	-	60	-	70	-
	Analyse										
Level 3	Evaluate	-	-	10	-	10	-		-	-	-
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100 %**	-	**100 %**	-

Recommended Resources

1. E. R. G. Eckert and R. M. Drake Jr, Analysis of Heat Transfer, McGraw-Hill, 1972
2. W. M. Roshenow and P. Choi, Heat, Mass and Momentum Transfer, Prentice - Hall, 1961
3. Karl Stephan, Heat Transfer in Condensation and boiling, Springer- Verlag,1992
4. John G. Collier, John R. Thome, Convective boiling and condensation, Oxford University Press, 1996
5. P. B. Whalley, Two Phase flow and heat transfer, Oxford University Press, 1996
6. F. P. Incropera, D. P. Dewitt, T. L. Bergman and A. S. Lavine, "Fundamentals of Heat and Mass Transfer", 7th Ed., John Wiley and Sons, 2011.
7. J. P. Holman, "Heat Transfer", 10th Ed., McGraw Hill, 2009.
8. Yunus A. Çengel, Afshin J. Ghajar, "Heat and mass transfer: fundamentals and applications", McGraw-Hill Education, 2015.
9. L. S. Tong and Y. S. Tang, Boiling Heat Transfer and Two-Phase Flow, Taylor and Francis, 1997
10. S. G. Kandlikar, Hand book of phase change: Boiling and Condensation, Taylor and Francis, 1999
11. Mamoru Ishii, Takashi Hibiki, Thermo-Fluid Dynamics of Two-Phase Flow, Springer-Verlag, 2011
12. Latif M. Jiji, Heat Conduction: Third Edition, Springer-Verlag Berlin Heidelberg, 2009.

Other Resources

1. Lectures by Prof. C. Balaji on Conduction& Radiaiton: https://www.youtube.com/watch?v=aLwJKZ1Gf3g&list=PL42D75EB85932E7D3
2. Boiling phenomena: https://www.youtube.com/watch?v=Py0GEByCke4

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

COMMUNITY SERVICE AND SOCIAL RESPONSIBILITY

Course Code	VAC 502	**Course Category**	VAC	**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CEL	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Encourage initiatives that address local needs, foster self-sufficiency, and promote environmental sustainability within the community.
2. Equip participants with a deeper understanding of social issues and a sense of responsibility towards marginalized communities.
3. Inspire active participation in community service programs and foster a culture of giving back among individuals and organizations.
4. Develop and implement programs that contribute to skill development, economic empowerment, and equal opportunities for underprivileged sections of society.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Develop effective strategies for identifying and addressing community needs.	3	80%	80%
Outcome 2	Demonstrate empathy and cultural sensitivity when engaging with diverse community groups.	4	80%	75%
Outcome 3	Implement sustainable solutions and evaluate their impact on social well-being.	5	90%	85%
Outcome 4	Collaborate effectively within teams to design and lead community service projects.	6	90%	80%

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments 50%**				**End Semester Exam 50%**
		CLA-1 20%	**Mid-1 20%**	**CLA-2 20%**	**CLA-3 20%**	
Level 1	Remember	10%	10%			20%
	Understand					
Level 2	Apply		10%	10%		20%
	Analyse					
Level 3	Evaluate				10%	10%
	Create					
Total		**10%**	**20%**	**10%**	**10%**	**50%**

SRM University *AP*, Andhra Pradesh
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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Research seminar

Course Code	AEC 503	Course Category	AEC		L	T	P	C
					0	0	1	1
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. To learn how to write the seminars in an effective way
2. To learn what are the skills needed for presentation of science
3. To learn effective science communication

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the features and characteristics seminars and presentations.	2	80%	80%
Outcome 2	Discuss methods of the presentation.	2	65%	60%
Outcome 3	Explain the parameters of conducting seminars.	3	65%	60%
Outcome 4	Discuss the responses to Q&A sessions in seminars.	2	60%	65%
Outcome 5	Explain conflict management during presentations and seminars.	3	80%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2		2	3	2	1			3	3	2	3	1	2	2
Outcome 2	2		2	3	2	1			3	3	2	3	2	2	1
Outcome 3	2		2	3	2	1			3	3	2	3	2	2	1
Outcome 4	2		2	3	2	1			3	3	2	3	2	2	1
Course Average	**2**		**2**	**3**	**2**	**3**		**3**	**3**	**3**	**2**	**3**	**2**	**2**	**1**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Explanation on what is a seminar and what are expected during the seminar, followed by student presentations		1,3	1,2
Unit No. 2	Discussion on tools for effective presentation		1, 2	3,4,5
Unit No. 3	Discussion and presentation demonstration		3	5
Unit No. 4	How to answer the questions during the presentation. Student presentation and discussion		4,5	6
Unit No. 5	How to manage the conflicts during the presentation		1, 4, 5	6

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Report (20%)		Mid-Review (30%)				
		Th	Prac	Th	Prac		Th	Prac
Level 1	Remember	40%		60%			30%	
	Understand							
Level 2	Apply	60%		40%			70%	
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**		**100%**			**100%**	

Recommended Resources

1. Brian Tracy, Speak to Win: How to Present with Power in Any Situation, Kindle Edition
2. Robert RH Anholt, Dazzle 'Em With Style: The Art of Oral Scientific Presentation, (ISBN: 0123694523)
3. Vernon Booth, Communicating in Science: Writing a Scientific Paper and Speaking at Scientific Meetings (ISBN: 0521429153)
4. Matt Carter Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More (ISBN: 0123859697)
5. Garr Reynolds Presentation Zen: Simple Ideas on Presentation Design and Delivery (ISBN: 0321811984)
6. Herbert Fensterheim and Jean Baer, Don't Say Yes When You Want to Say No: Making Life Right When It Feels All Wrong, Mass Market, 1975.

Other Resources

1.Article, How to write consistently boring scientific literature by Kaj Sand-Jensen. doi/10.1111/j.0030-1299.2007.15674.x

Course Designers

1. Dr. Sangjukta Devi, Assistant Professor, Department of Mechanical Engineering, SRM university AP.

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Entrepreneurial Mindset

Course Code	SEC 103	Course Category	SEC	L	T	P	C
				1	0	1	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Management	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To develop the Entrepreneurial Mindset of Students.
2. To provide students an overview of different aspects of starting a business.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Recall the key entrepreneurship concepts and entrepreneurial traits	1	90%	80%
Outcome 2	Identify entrepreneurial opportunities	2	80%	80%
Outcome 3	Apply entrepreneurial skills to analyze different entrepreneurial ventures.	3	70%	70%
Outcome 4	Apply entrepreneurial concepts to and develop a business model canvas	3	60%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3			2				2		2	2				3
Outcome 2	1	3	3	3				3			3				1
Outcome 3	2	3	3	3				3		2	3				2
Outcome 4	3	3	3	3				3		3	3				3
Average	2	3	3	3				3		2	3				2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**2**	**1,3**	
1.	What is Entrepreneurship			
2.	Challenges Faced by Entrepreneurs			
3.	Why not entrepreneurship			
4.	Who is an Entrepreneurs (Characteristics and Myths)			
5.	Why become entrepreneurs			
6.	Entrepreneurial Traits			
7.	Significance of entrepreneurship in the economy			
8.	Types of Entrepreneurial Ventures			
Unit 2	**Entrepreneurial Orientation**	4	1,2,4	
9.	Characteristics of successful entrepreneurs			
10.	Mindset shifts: from an employee to an entrepreneur			
11.	Overcoming challenges and dealing with failures			
Unit 3	**Entrepreneurial Skills**	**4**	1,2,3,4	
12.	Innovation & Creativity			
13.	Design Thinking			
14.	Strategic Thinking			
15.	Developing a Growth Mindset			
Unit 4	**Technopreneurship**	**2**	1,2	
16.	Overview of Technopreneurship			
17.	Characteristics of a Technopreneur			
18.	Technology Trends and Disruption			
19.	Real-world Technopreneurship Examples			
Unit 5	**Entrepreneurial Opportunity & Ideation**	4	2	
20.	Difference between idea and opportunity			
21.	Opportunities in Vibrant Indian Entrepreneurial Ecosystem			
22.	Opportunity Recognition (Sources of Opportunity)			
23.	Assessing Opportunity			
24.	Opportunities and Uncertainty			
25.	Idea Generation & Market Research			
26.	Idea Selection			
Unit 6	Business Model Canvas & Pitching	2	1,4	
27.	Why BMC			
28.	Value Proposition			
29.	Customer Discovery			
30.	Customer Relationship			
31.	Channels			
32.	Key Partners			
33.	Key Activities			
34.	Key Resources			
35.	Revenue Structure			
36.	Cost Structure			
37.	From Pitch to Hitch (Pitch Deck)			

Unit 7	Startup Financing	2	1,4	
38.	Stages of Fund Raising			
39.	Startup Valuation			
40.	Mode of Investment			
41.	Shareholder's Agreement			
42.	Financial Analysis			
Total Contact Hours		**20**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (100%)**		
		CLA-1 (30%)	**CLA-2 (30%)**	**CLA-3 (40%)**
Level 1	Remember	100%	40%	
	Understand			
Level 2	Apply		60%	100%
	Analyse			
Level 3	Evaluate			
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Larry Keeley Brian Quinn Ryan Pikkel. Ten types of innovation -the discipline of building breakthroughs, John Wiley& Sons, Inc; 2013
2. Eric Ries. The lean startup how constant innovation creates radically successful businesses, Penguin Books
3. Bruce R. Barringer, R. Duane Ireland. Entrepreneurship Successfully Launching New Ventures, Pearson; 2020
4. Robert D. Hasrich, Dean A. Shepherd, Michael P. Peters, Entrepreneurship, McGraw Hill, 2020
5. Siva Prasad N. Design Thinking : Techniques And Approaches, Ane Books, New Delhi; 2023

Other Resources

1. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship
2. https://www.coursera.org/specializations/wharton-entrepreneurship

Course Designers

1. Mr Aftab Alam, Assistant Professor, Paari School of Business, SRM University-AP
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3. Prof. Bharadhwaj S, Dean, Paari School of Business, SRM University-AP

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Thermal Design for Electronics Equipment-TDEE

Course Code	THE 505	**Course Category**	CC	**L**	**T**	**P**	**C**
				2	1	1	4
Pre-Requisite Course(s)	Fluid Mechanics, Heat transfer, Thermodynamics, Calculus	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To enhance the overview of the introduction of thermal design for electronics devices.
2. To understand the relevance of cooling technologies for electronics devices.
3. To enhance the understanding and utility of heat transfer mechanisms and thermos-physical properties in different electronics systems.
4. To implement the fundamental knowledge of heat transfer, fluid mechanics and thermodynamics laws to thermal design of electronics applications and perform analysis.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Identify the fluid mechanics and heat transfer laws, modes of heat transfer and applications of these modes to electronics engineering systems.	2	70%	80%
Outcome 2	Apply the in depth understanding of fundamentals of electronics packaging and data centres, Conjugate heat conduction and thermal spreading.	3	70%	80%
Outcome 3	Apply different cooling techniques for thermal management of electronics.	4	70%	80%
Outcome 4	Analyse and design primitive thermal management for electronics packaging.	4	70%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**										**-**		
	Engineering Knowledge	**Design / Development of Solutions**	**Conduct Investigations**	**Modern Tool Usage**	**The Engineer**	**Environment**	**Ethics**	**Individual and Team Work**	**Communication**	**Life-long**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	2	2	2	2	-	-	2	-	3	3	2	2
Outcome 2	3	3	2	3	3	-	-	3	-	3	2	3	2
Outcome 3	3	3	3	3	3	-	-	3	-	3	2	3	3
Outcome 4	2	3	2	3	3	-	-	3	-	3	3	3	3
Course Average	**3**	**3**	**2**	**3**	**3**	-	-	**3**	-	**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Fundamentals of Heat Transfer: Review of Conduction, Convection and Radiation heat transfer.	2	1	1,2,5
	Introduction to electronics packaging	1	1	1,4
	Basic definitions of electronics packaging,	1	1	1,4
	classification of electronics packaging and self- heating in electronics packaging.	1	1	1,4
Unit No. 2	Introduction to thermal management of electronics packages and datacentres: Basic definitions of thermal management, classification of thermal management of electronics packages and datacentres	2	2, 4	1, 2, 3, 4
	Concept of Contact resistance elastic-elastic contacts and elastic plastic contacts.	3	2, 5	1, 2, 3, 8
	Conjugate heat conduction and thermal spreading: Derivation of analytical solution of heat spreading in heat sink base.	4	2, 5	1, 2, 3, 8
	Fin analysis and heat sink design: Derivation of general thermal resistance network.	4	2, 5	1, 2, 3, 4,7,8
Unit No. 3	Natural convection in electronics packaging, Radiation in electronic packages. Forced convection in electronics,	4	1,3,4	1, 2, 3, 5, 6
	Liquid cold plates for electronics, Jet impingement analytical solution derivation,	3	3,4,5	1, 2, 3, 5, 6
	Boiling and Condensation, Immersion cooling of electronics, design considerations.	3	3,4,5	1, 2, 3, 5, 6
	Introduction to heat pipes, Phase change energy storage with PCM's. Microchannel heat exchangers, Piezoelectric fans and synthetic jets.	2	3,4,5	1, 2, 3, 5, 6, 8
Unit No. 4	Thermoelectric modules, derivation of analytical solution, Acoustic challenges,	2	3, 4	1, 2, 3, 6, 8
	thermal modelling of electronics packages and printed circuits	2	3, 4	1, 2, 3, 6, 8
	Thermal design of fan heat sinks: fan/blower curves, parallel plate fins,	3	3, 4	1, 2, 3, 6, 8
	manufacturing processes, design for manufacturability.	3	3, 4	1, 2, 3, 6, 8
Unit No. 5	Thermal design of smartphones and tablets: case studies	1	4	1, 2, 4, 8
	Thermal design of IT data centers Part 1 (IT equipment loop).	1	4	1, 2, 4, 8
	Thermal design of IT data centers Part 2 (IT facilities loop) chip to cooling tower Thermal design.	2	3, 4, 5	1, 2, 4, 6, 8
	Thermal design of IT data centers Part 2 (IT facilities loop) chip to cooling tower Thermal design.	1	3, 4, 5	1, 2, 4, 6, 8

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (10%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	30	-	20		20		40	-	30	-
	Understand										
Level 2	Apply	70	-	70		70		60	-	70	-
	Analyse										
Level 3	Evaluate	-	-	10		10			-	-	-
	Create										
Total		**100%**	**-**	**100%**		**100%**		**100%**	**-**	**100%**	**-**

Recommended Resources

1. Lian-Tuu Yeh, Richard C. Chu, Dereje Agonafer, "Thermal management of microelectronic equipment heat transfer theory, analysis methods and design practices", ASME press, 2002
2. F. P. Incropera, D. P. Dewitt, T. L. Bergman and A. S. Lavine, "Fundamentals of Heat and Mass Transfer", 7th Ed., John Wiley and Sons, 2011.
3. Allen D. Kraus and Avram Bar Cohen, "Design and Analysis of Heat Sinks", Wiley-Interscience, 2008
4. Tummala Rao R., "Fundamentals of Microsystems packaging", McGrawHill, 2004
5. Yunus A. Çengel, Afshin J. Ghajar, "Heat and mass transfer: fundamentals and applications", McGraw-Hill Education, 2015
6. Ho Sung Lee, "Thermal Design: Heat Sinks, Thermo-electrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells", John Wiley and Sons, 2010
7. Adrian Bejan, Allan D. Kraus, "Heat Tranfer Handbook", Wiley-Interscience, 2003
8. Ralph Remsburg, "Thermal Design of Electronic Equipment", CRC Press LLC, 2001

Other Resources

1. Moore's Law: https://www.visualcapitalist.com/visualizing-moores-law-in-action-1971-2019
2. Property data: http://www.mhtlab.uwaterloo.ca
3. Packaging: https://www.intel.com/content/www/us/en/silicon-innovations/silicon-innovations-technology.html
4. Prof. Yovanovich site for Analytical solutions: http://www mhtl uwaterloo ca/RScalculators html#SpreadingResistance

Course Designers

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MICRO AND NANOSCALE HEAT TRANSFER

Course Code	THE506	**Course Category**	CC		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	THE504	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Enhanced understanding on modelling challenges of energy transport phenomena at different scales especially at micro and nano scale
2. Fundamental understanding of micro and nanoscale transport in various fields of current interest especially in the field of electronic components
3. Enhanced understanding on analysing the real time cooling challenges of electronic components and applying advanced methods to model heat transfer at small scale

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Illustrate the recent developments in thermal sciences and engineering related to micro/nanoscale energy transport and technologies.	3	70%	65%
Outcome 2	Investigate the microscopic descriptions and approaches in thermal science, like equilibrium statistics, Boltzmann transport equation.	3	70%	65%
Outcome 3	Investigate the nanoscale energy transport phenomena such as nanoscale heat conduction and radiation.	3	70%	65%
Outcome 4	Examine, evaluate and solving the real time engineering challenges in the area of electronic cooling using advanced knowledge of micro and nanoscale scale heat transfer concepts.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)												
	Engineering Knowledge	Design and Development	Conduct Investigations of	Modern Tool and ICT Usage	The Engineer and Society	Environment and Sustainabilit	Moral, and Ethical Awareness	Individual and Teamwork	Communication Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	3	2	-	2	1	3	3	3	3
Outcome 2	3	3	3	3	3	2	-	2	1	3	3	3	3
Outcome 3	3	3	3	3	3	2	-	2	1	3	3	3	3
Outcome 4	3	3	3	3	3	2	-	2	1	3	3	3	3
Course Average	3	3	3	3	3	2	-	2	1	3	3	3	3

Course Unitization Plan- - Theory

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Ranges of scales, Limitations of Knudsen number.	2	1,2	1, 2, 3
	Advantage of Boltzmann equation for high Kn flows, Distinguished factors at high Kn numbers	2	1,2	1, 2, 3
	Advantages of microchannels in the context of energy transport, microelectronic devices and applications.	2	1,2,4	1, 2, 3
	Limitations of macroscopic laws for small length scales.	2	1,2,4	1, 2, 3
	Introduction to nanoscale energy transport.	2	1,2,3	1, 2, 3
Unit No. 2	Heat conduction equation for continuum energy transport and constitutive loss of heat transfer.	2	1,2	1, 2, 3
	Applicability of constitute laws for microscale energy transport, Energy or momentum possessed by energy carriers,	2	1,2	1, 2, 3
	Basic wave characteristics: standing wave, travelling wave, derivation of energy possessed by a wave in a given distance. Schrodinger's wave equation.	3	1,2	1, 2, 3
	Different forms of wave functions. Heisenberg uncertainty, Particle in a 1D confinement.	2	1,2	1, 2, 3
Unit No. 3	Fundamentals of statistical thermodynamics	4	1,2	1, 2, 3
	Distribution of energy carriers	4	1,2	1, 2, 3
Unit No. 4	Fundamentals of nanoscale transport	4	1,3	1, 2, 3
Unit No. 5	Single phase heat transfer in microchannel	4	1,2,3,4	1, 2, 3
	Gas flows and heat transport in microchannels	2	1,2,3,4	1, 2, 3
	Applications of nanofluids in microchannels	4	1,2,3,4	1, 2, 3
	Applications of microfluidics and nanofluidic	4	1,2,3,4	1, 2, 3

Course Unitization Plan-Research based learning/Project:

Students will be assigned to read several research articles and present every week. Based on their understanding and interpretations, evaluation will be carried out. Also, students will be asked to validate (reproduce) the literature results using simulations.

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory(30%)				Project (20%)		
		CLA-1 (5%)	CLA-2 (5%)	CLA-3 (10%)	Mid Term (10%)		Th	Project
Level 1	Remember	20%	10%	10%	10%	10%	15%	10%
	Understand							
Level 2	Apply	80%	90%	90%	90%	90%	85%	90%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Microscale and nanoscale heat transfer, "C.B Sobhan and G.P Peterson, CRC press, 2008.
2. Nanoscale energy transport and conversion, "Gang Chen, Oxford University press, 3.
3. 2005.Nano/Microscale heat transfer, "ZhuominZhang, McGraw-Hill,2007.

Course Designers

1. Dr. Lakshmi Sirisha Maganti, Assistant Professor, Department of Mechanical Engineering, SRM University-AP, Andhra Pradesh.

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Computational Techniques for Electronic Cooling

Course Code	THE 507	Course Category	CC	L	T	P	C
				1	1	2	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Predict and derive the solution methodologies.
2. Identify advantages and disadvantages of various methods to solve a particular problem.
3. Apply the knowledge of the methods to engineering applications.
4. Study the computational implementation of the methods.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Classify solution techniques for simulations	2,4	80%	75%
Outcome 2	Derive the discretised equations	2	70%	65%
Outcome 3	Demonstrate the ability to use multiple CFD simulation tools	3,4	70%	65%
Outcome 4	Proficiency In simulations of various engineering problems	4,5	60%	55%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	1	2	2	-	-	-	-	3	3	2	3	3	2
Outcome 2	3	3	2	3	2	-	-	-	-	3	3	2	3	3	3
Outcome 3	3	3	3	3	2	-	-	-	-	3	3	2	3	3	3
Outcome 4	3	3	3	3	3	-	-	-	-	3	3	3	3	3	3
Course Average	3	3	3	3	3	-	-	-	-	3	3	2	3	3	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Importance of Thermal Management in Electronics	1	1	1, 2,3, 4
	Heat Generation in Electronic Devices	1	1	1
	Introduction to CFD and Thermal Simulation	1	1	1, 3
Unit No. 2	Basic Principles of Heat Transfer (Conduction, Convection, Radiation)	1	1	1
	CFD Fundamentals	0.5	1	2,3
	Mesh Generation and Quality	2	2	1
	Boundary Conditions and Solver Settings	0.5	2	1, 2
Unit No. 3	Methods for pressure linked equation	3	2	1, 3
	Advantages and disadvantages of the methods	2	2	1, 3
	Introduction to Finite volume method	4	2	1, 2
Unit No. 4	Structured grid computing	3	2	1
	Overview of simulation software (ANSYS Fluent, OpenFOAM)	4	2	1, 3
	Structured mesh generation software, Gmsh and ICEMCFD	3	2	1, 2
Unit No. 5	Overview of turbulence models (k-epsilon, k-omega, LES)	2	2	1, 3
	Application of turbulence models in electronic cooling	2	2	1, 3
	Students will do a major project using ANSYS or OpenFOAM	4	2	1, 3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (30%)								End Semester Exam (70%)	
		CLA-1 (10 %)		CLA-2 (10 %)		CLA-3 (10%)		Mid Term (__%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember										
	Understand	20								40	
Level 2	Apply	80		10		20				20	20
	Analyse			20		60				40	30
Level 3	Evaluate			30		20					50
	Create										
Total										**25**	**45**

Recommended Resources

1. Anderson J.D., "Computational Fluid dynamics", McGraw Hill Int., New York, 2010.
2. Computational Fluid Dynamics, An Open-Source Approach. Brian C. Vermeire, Carlos A.Pereira and

Other Resources

1. Hamidreza Karbasian. https://users.encs.concordia.ca/~bvermeir/files/CFD%20-%20An%20Open-Source%20Approach.pdf
2. Versteeg H.K., and Malalasekera W., "An introduction to computational fluid dynamics, The finite volume method", Longman, 2007.
3. ANSYS© guide
4. OpenFOAM https://www.openfoam.com/documentation/user-guide
5. Gmsh http://gmsh.info/
6. Paraview https://www.paraview.org/
7. ICEMCFD https://www.ansys.com/products/fluids/ansys-icem-cfd.

Course Designers

1. Dr Satya Pramod Jammy, Associate Professor, Department of Mechanical Engineering, SRM University.

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Thesis - I

Course Code	THE 509	**Course Category**	RDIP	**L**	**T**	**P**	**C**
				0	0	14	14
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To learn how to define the research objective.
2. To acquire skills to solve the problem statement.
3. To learn how to prepare scientific presentations.
4. To develop skills for project management and writing scientific reports.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Formulate research objective	2	80%	80%
Outcome 2	Describe the method (experiments or simulation to attain objective)	2	65%	60%
Outcome 3	Describe the research outcome through presentation	3	65%	60%
Outcome 4	Find out how to write thesis	2	60%	65%
Outcome 5	Study about various instrumentation techniques used during presentations.	3	80%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2	-	2	3	2	1	-	-	3	3	2	3	1	2	2
Outcome 2	2	-	2	3	2	1	-	-	3	3	2	3	2	2	1
Outcome 3	2	-	2	3	2	1	-	-	3	3	2	3	2	2	1
Outcome 4	2	-	2	3	2	1	-	-	3	3	2	3	2	2	2
Average	2	-	2	3	2	3	-	3	3	3	2	3	2	3	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Clearly articulating the problem that the project aims to solve, Describing the current state of affairs and why a solution is necessary	3	1	1,5
Unit No. 2	Application of various methods and approaches to ensure successful execution of Project	3	2	1,5
Unit No. 3	The obtained results must be interpreted utilising appropriate software, tools, and techniques. Validation of results with standard data base	4	3	2,3,5
Unit No. 4	Making a scientific presentation of the results obtained with appropriate reasoning.	2	3	2,3
Unit No. 5	Obtained results is summarized in the form thesis/manuscript/report	3	4	4,5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)		End Semester Exam (50%)
		Project Review 1 (25%)	Project Review 2 (25%)	
Level 1	Remember	-	-	-
	Understand			
Level 2	Apply	50%	50%	50%
	Analyse			
Level 3	Evaluate	50%	50%	50%
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Problem Solving for Engineers and Scientists: A Creative Approach (https://doi.org/10.1007/978-1-4615-3906-3)
2. Matt Carter Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More (ISBN: 0123859697)
3. Garr Reynolds Presentation Zen: Simple Ideas on Presentation Design and Delivery (ISBN: 0321811984)
4. Article, how to write consistently boring scientific literature by Kaj Sand-Jensen. doi/10.1111/j.0030-1299.2007. 15674.x
5. Keshav S. How to read a paper. ACM SIGCOMM Computer Communication Review. 2007 Jul 20;37(3):83-4.

Course Designers

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Industrial Practice

Course Code	THE 510	Course Category	RDIP	L	T	P	C
				0	0	3	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mechanical Engineering	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To learn how to define the research objective.
2. To acquire skills to solve the problem statement.
3. To learn how to prepare scientific presentations.
4. To develop skills for project management and writing scientific reports.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Formulate research objective	2	80%	80%
Outcome 2	Describe the method (experiments or simulation to attain objective)	2	65%	60%
Outcome 3	Describe the research outcome through presentation	3	65%	60%
Outcome 4	Find out how to write thesis	2	60%	65%
Outcome 5	Study about various instrumentation techniques used during presentations.	3	80%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	-	2	3	2	1	-	-	3	3	2	3	1	2	2
Outcome 2	2	-	2	3	2	1	-	-	3	3	2	3	2	2	1
Outcome 3	2	-	2	3	2	1	-	-	3	3	2	3	2	2	1
Outcome 4	2	-	2	3	2	1	-	-	3	3	2	3	2	2	2
Outcome 5	2	-	2	3	2	3	-	3	3	3	2	3	2	3	2
Average	2	-	2	3	2	1	-	3	3	3	2	3	2	2	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Clearly articulating the problem that the project aims to solve, Describing the current state of affairs and why a solution is necessary	5	1	1,5
Unit No. 2	Application of various methods and approaches to ensure successful execution of Project	7	2	1,5
Unit No. 3	The obtained results must be interpreted utilising appropriate software, tools, and techniques. Validation of results with standard data base	8	3	2,3,5
Unit No. 4	Making a scientific presentation of the results obtained with appropriate reasoning.	5	3	2,3
Unit No. 5	Obtained results is summarized in the form thesis/manuscript/report	5	4	4,5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)		End Semester Exam (50%)
		Project Review 1 (25%)	Project Review 2 (25%)	
Level 1	Remember	-	-	-
	Understand			
Level 2	Apply	50%	50%	50%
	Analyse			
Level 3	Evaluate	50%	50%	50%
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Problem Solving for Engineers and Scientists: A Creative Approach (https://doi.org/10.1007/978-1-4615-3906-3)
2. Matt Carter Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More (ISBN: 0123859697)
3. Garr Reynolds Presentation Zen: Simple Ideas on Presentation Design and Delivery (ISBN: 0321811984)
4. Article, how to write consistently boring scientific literature by Kaj Sand-Jensen. doi/10.1111/j.0030-1299.2007. 15674.x
5. Keshav S. How to read a paper. ACM SIGCOMM Computer Communication Review. 2007 Jul 20;37(3):83-4.

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Introduction to Multiphase flows

Course Code	THE 530	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	1	4
Pre-Requisite Course(s)	Fluid Mechanics, Heat Transfer	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mechanical Engineering	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the fundamental concepts, principles, and application of multiphase flow.
2. To learn various mathematical models for multiphase flow systems and hydrodynamic flow regimes maps
3. To strengthen analytical and numerical abilities to solve complex two- and three-phase flow problems such as bubbly and slug flows.
4. Learning measurement techniques associated with multiphase flow.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	To have a general introduction to the theory of multiphase flow in connection with real-life examples and its importance in process industries.	**2**	**70%**	**80%**
Outcome 2	Develop a general understanding about the hydrodynamics of multiphase flows with various flow regimes, and flow regime maps.	**3**	**70%**	**80%**
Outcome 3	Students will learn various analytical models to develop a comprehensive understanding of numerical modelling of multiphase flow.	**4**	**70%**	**80%**
Outcome 4	Exposure to measurement techniques employed in multiphase flow system.	**4**	**70%**	**80%**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)												
	Engineering Knowledge	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	2	-	-	2	-	-	3	3	3
Outcome 2	3	3	2	3	3	-	-	2	-	-	3	3	3
Outcome 3	3	3	3	3	3	-	-	3	-	-	3	3	3
Outcome 4	2	3	2	3	3	-	-	2	-	-	3	3	3
Course Average	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**2**	**-**	**-**	3	3	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Review of fundamentals of Fluid Mechanics	**1.5**	**1**	**1, 2**
	Introduction to multiphase flow	**1.5**		
	Types and applications, common terminologies			
	Flow patterns and flow pattern maps	**2**		
Unit No. 2	One dimensional steady homogenous flow, Concept of choking, and critical flow phenomena	**4**	**2, 4**	**1, 2**
	One dimensional steady separated flow model in case the phases considered together with different velocities	**5**	**1, 2, 4**	
	1D steady separated flow in the case wherein phases are considered separately,	**3**		**1, 2**
Unit No. 3	The separated flow model for stratified and annular flow	**2**	**2, 3**	**1 ,2, 5**
	Flow in which inertia effects dominate, energy equations	**5**		
	The general theory of drift flux model. Application of drift flux model to bubbly and slug flow	**5**		
Unit No. 4	An introduction to three-phase flow with examples	**1.5**	**2, 3, 4**	**3, 4**
	Bubble departure, release frequency, nucleation site density	**2.5**		
	Heat transfer mechanism, pool boiling correlation equation, VDI correlation	**3**		
	Hydrodynamics of solid-liquid and gas-solid flow.	**4**		
Unit No. 5	Measurement techniques for multiphase flow: Flow regime identification	**2**	**1, 2, 4**	**4, 5**
	Measurement of pressure drop and void fraction	**1.5**		
	Flow rate measuring techniques in multiphase flow	**1.5**		

Course Unitization Plan- Project:

In this course, the focus will be on project-based learning. To this end, students will be assigned or pick a term project on a multiphase flow problem of their choice (experimental/numerical) and apply the discussed concepts, and articles to work through the project. Students will be asked to present the work done on monthly basis to review the progress and evaluation will be carried out based on final presentation on the project.

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (75%)				End Semester Exam (25%)
		CLA-1 (10%)	CLA-2 (10%)	Mid Term (25%)	Project (30%)	
		Th	Th	Th	Prac	Th
Level 1	Remember	30%	40%	40%	40%	30%
	Understand					
Level 2	Apply	70%	60%	60%	60%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Wallis, Graham B. *One-dimensional two-phase flow*. Courier Dover Publications, 2020.
2. Brennen, Christopher E. *Fundamentals of multiphase flow*. 2005.
3. Crowe, Clayton T. *Multiphase flow handbook*. CRC press, 2005.
4. Bertola, Volfango, ed. *Modelling and experimentation in two-phase flow*. Vol. 450. Springer, 2014.
5. Butterworth, David, and Geoffrey Frederick Hewitt. *Two-phase flow and heat transfer,* 1977

Other Resources

1. https://youtube.com/playlist?list=PLyMtJ7HNLrEOIAkdIPfd3OTkDRHdDfUS5&si=cCR7SKA-do_LiNlF

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Design of Heat Exchange equipment

Course Code	THE 531	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	1	1	4
Pre-Requisite Course(s)	**Heat transfer, Thermodynamics**	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	**Mechanical Engineering**	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the fundamental concepts, principles, and application of heat exchangers
2. To learn about various kinds of heat exchangers
3. To learn various design methods for heat exchangers.
4. Analyze and evaluate the performance of heat exchangers

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Students learn the summarize of different types of heat exchanger used in application.	2	70%	80%
Outcome 2	Students learn to design and estimate the performance of shell and tube type heat exchanger.	3	70%	80%
Outcome 3	Students learn to design and analyze the performance of tube finned heat exchanger.	4	70%	80%
Outcome 4	Students learn to design and evaluate the performance of plate finned heat exchanger.	4	70%	80%
Outcome 5	Students learn to design regenerators and heat pipes	3	70%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	2			2						3	2
Outcome 2	3	3	2	3	3			2						3	3
Outcome 3	3	3	3	3	3			3						3	3
Outcome 4	2	3	2	3	3			2						2	3
Course Average	**3**	**3**	**2**	**3**	**3**			**2**						**3**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Classification, selection, overall heat transfer coefficient	2	1	1, 2
	LMTD method for heat exchanger analysis for parallel, counter, multi-pass and cross flow heat exchanger	2	1	1,2
	e-NTU method for heat exchanger analysis	2	1	1,2
Unit No. 2	Numerical problems and solutions	6		1,2,3
Unit No. 3	Different designs and special types.	1	1, 2	1,2,3
	Brief description of Shell and Tube Heat Exchangers	1	1, 2	1,2,3
	Design procedure of Shell and Tube Heat Exchangers	3	1,2	
Unit No. 4	Enhancement of heat transfer	2	1,3	3, 4, 5
	Extended surface or Fin, fundamental of extended surface heat transfer,	3	1,3	3, 4, 5
	Fin tube heat exchanger	3	1,3,4	3, 4, 5
Unit No. 5	Types and applications	2	1, 4	1,2,3,4,5
	Design and construction	5	1,4	1,2,3,4,5
Unit No. 6	Types of regenerators	1	1,5	1,2,3,4,5
	Theory and application of regenerators	2	1, 5	1,2,3,4,5
	Design and construction	4	1,5	1,2,3,4,5
Unit No. 7	Working principle and applications	3	1,5	1,2,3,4,5
	Construction and analysis	3	1,5	1,2,3,4,5
	Working principle and applications	3	1,5	1,2,3,4,5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (25%)	CLA-2 (5%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember	30%	40%	40%	40%	30%
	Understand					
Level 2	Apply	70%	60%	60%	60%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Heat Transfer Equipment Design, R. K. Shah, Eleswarapu Chinna Subbarao, R. A. Mashelkar, CRC Press
2. Fundamentals of Heat Exchanger Design by Ramesh K.Shah and Dusan P.Sekulic, JOHN WILEY & SONS, INC
3. Compact Heat Exchangers by Kays, V.A. and London, A.L., McGraw Hill
4. S. Kakaç, H. Liu, A. Pramuanjaroenkij, Heat Exchangers: Selection, Rating, and Thermal Design, Third Edition, CRC Press, 2012.
5. Heat Exchanger Design Handbook by Kuppan, T, Macel Dekker, CRC Press

Other Resources

Course Designers

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