NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR DEPARTMENT OF MECHANICAL ENGINEERING

Revised Curriculum and Syllabi

Program Name Master of Technology in Fluid Mechanics and Heat Transfer Effective from the Academic Year: 2021-2022



Recommended by DPAC	: 03.08.2021
Recommended in PGAC	: 16.08.2021
Approved by the Senate	: 22.08.2021

Sl. No.	Subject Code	Name of the Subject	L	Т	S	С	Н
Sem	ester I						
1.	ME 1011	Advanced Fluid Mechanics	3	1	0	4	4
2.	ME 1012	Mathematical Methods in Engineering	3	1	0	4	4
3.	ME 1013	Convective Heat and Mass Transfer	3	1	0	4	4
4.	ME 90**	Specialization Elective - I	3	0	0	3	3
5.	ME 90**	Specialization Elective - II	3	0	0	3	3
6.	ME 1061	Thermo-Fluids Laboratory	0	0	4	2	4
7.	ME 1062	Numerical Simulation Laboratory	0	0	4	2	4
			To	otal C	redit	22	26
Sem	ester II						
1.	ME 2011	Microfluidics	3	1	0	4	4
2.	ME 2012	Computational Fluid Flow and Heat	3	1	0	4	4
		Transfer					
_	ME 2013 /	Core- Elective	3	1	0	4	4
3.	ME 2014			0	0		2
4.	ME 90**	Elective-III	3	0	0	3	3
5.	ME 90**	Elective-IV	3	0	0	3	3
6.	ME 2061	CFD Laboratory	0	0	4	2	4
7.	ME 2062	Mini Project with Seminar	0	0	6	3	6
Total Credit 23							28
Sem	ester III						
1.	XX90XX	AUDIT LECTURES / WORKSHOPS	0	0	0	0	2
2.	ME 3061	DISSERTATION - I	0	0	24	12	24
3.	ME 3062	SEMINAR - NON-PROJECT /	0	0	4	2	4
		EVALUATION OF SUMMER					
		IRAINING	Т	tol C	rodit	14	20
Som	ostor IV		10	nai C	leun	14	30
		DISCEPTATION II / INDUSTRIAL	0	0	24	10	24
1.	WIE 4001	PROJECT	U	U	24	12	24
2.	ME 4062	PROJECT SEMINAR	0	0	4	2	4
			To	tal C	redit	14	28
		TOTAL CREDIT POINT: 73					

CURRICULUM

LIST OF ELECTIVE SUBJECTS

SI.	Subject Code	Name of the Subject
INO.		
1.	ME 9041	Experimental Methods in Thermal Science
2	ME 9042	Dynamical Systems
3	ME 9043	Fundamentals of Combustion
4	ME 9044	Fluid Power Systems and Control
5	ME 9045	Advanced Theory of Turbomachinery
6.	ME 9046	Lubrication Engineering
7.	ME 9047	Multi-Phase Flow and Heat Transfer
8.	ME 9048	Advanced Computational Fluid Dynamics
9.	ME 9049	Turbulence and Turbulent Flows
10.	ME 9050	Introduction to Aerodynamics
11	ME 9051	Microsystem Design
12	ME 9052	Gas Turbines and Jet Propulsion
13	ME 9053	Theory of Combustion
14	ME 9054	Renewable Energy Sources
15	ME 9055	Power Plant Engineering
16	ME 9056	Heat and Fluid Flow in Porous Media

LIST OF CORE- ELECTIVE SUBJECTS

SL NO	Subject Code	Name of the Subject
1.	ME2013	Conduction and Radiation Heat Transfer
2.	ME2014	Compressible Flow

	Department of Mechanical Engineering							
Course	Title of the course	Program Core	Total Nu	mber of cor	ntact hours	•	Credit	
Code		(PCR) /	Lecture	Tutorial	Practical	Total		
		Electives	(L)	(T)	(P)	Hours		
		(PEL)						
ME1011	Advanced Fluid	PCR	3	1	0	4	4	
	Mechanics							
Pre-requisi	ites	Course Assessm (EA)	ent methods	s (Continuo	us (CT) and	end assess	ment	
Fluid Mool	hanica Engineering	$(\mathbf{L}\mathbf{A}))$						
Mathemati	cs in UG Programme							
Course	$\bullet CO1 \cdot To intro$	duce fundamental	concent of t	fluid and its	properties: (concept of		
Outcomes	continuum	Judee Tundumentur	concept of 1	ind and his	properties.	oncept of		
	• CO2: To intr	• CO2: To introduce type of analysis of fluid motion						
	• CO3: To learn fundamental equations of fluid flow							
	• CO4: To lear	n analytical solution	ns of some s	steady and	unsteady inc	ompressib	le flows	
	• CO5: To learn hydrodynamic stability							
	• CO6: To lear	n concept of creepi	۔ ng flow and	hydrodyna	mic lubricati	on.		
	• CO7: To loom	n houndary layar a	naant					
	• CO7: 10 lean	n boundary layer co	Jicept					
	• CO8: To learn	n concept of potent	ial flow					
	• CO9: To learn	n fundamental conc	ept of turbu	lence and t	urbulent flow	ν.		
Topics Covered	 Introduction, of describing 	lefinition of fluids,	concepts of	f stress, stre	ess tensor, di	fferent ap	proaches	
covered	conservation 1	aws for control volu	ume	ansport the	eorem and	ns applie	(8)	
	 Kinematics of 	fluid motion relati	ve motion c	f fluid part	icles Newton	n's law of	(0)	
	- Kinematics of	ulates of Stokes, read	lotion botwy	on atraga ta	near to the r	to of strai	n tonsor	
	(Stalsasian flux	ulates of Stokes, le						
	(Stokestan nu	(u), Navier Stokes e				npressible	(10)	
	exact solution	of Navier Stokes e	quation for s	several spec	cial cases.	11 01	(12)	
	 Introduction to 	o hydrodynamic st	ability, line	ar stability	of plane Po	iseuille fl	ow, Orr-	
	Sommerfeld e	quation, unsteady of	exact solution	on of Navie	er Stokes equ	ation: Sto	okes first	
	and second pr	roblem, hydrodyna	mic theory	of lubricat	tion, thin fil	m equation	on, slider	
	bearing.						(10)	
	 Potential flow 	: Stokes' theorem,	, Laplace's	equation, o	circulation, s	tram func	tion and	
	velocity poten	tial, fundamental	potential flo	ows, combi	ned flows, l	ift and dı	ag for a	
	cylinder with a	and without circular	tion.				(8)	
	 High Revnold 	s number flow past	t a semi-infi	inite plate.	and concept	of bounda	ry laver.	
	Prandtl's hour	ndary laver equation	ion. approx	imate (von	Karman m	omentum	integral	
	method) and e	exact solutions (RI	sius colutio	(0) of the h	oundary lave	er equation	n for flat	
	nloto houndar	v laver with press	ra gradiant	Fallman Cl	con flow post	a wadaa	(10) (10)	
	prate, boundar	y layer with pressu	ie gradient,:	raikiter P	an now past	a weuge	(10)	
	Introduction to	o turbulence, Reyno	bids decomp	Dosition, Re	ynolds-avera	iged Navie	er Stokes	
	equation, cond	cept of turbulent st	resses, Prar	ndlt's mixin	ig length hyp	pothesis, r	near wall	

	velocity profile: law of the wall and velocity defect law, concept of eddy viscosity, turbulent intensity, turbulent kinetic energy. (8)
Text Books, and/or reference material	Text Books: 1. Title:Viscous Fluid Flow Author: White F.W. 2. Title: Boundary Layer Theory Author: Schlichting S. 3. Title:Viscous Flow Author: Sherman F.
	 Reference Books 1. Title: Advanced Engineering Fluid Mechanics, Author: Muralidhar K.M., Biswas G. 2. Title: An Introduction to Fluid Dynamics, Author: Batchelor, G.K. 3. Title: Incompressible Flow: Panton, R. L.

	Department of Mechanical Engineering						
Course	Title of the	Program Core	Total Nu	mber of conta	et hours		Credit
Code	course	(PCR) /	Lecture	Tutorial (T)	Practical	Total	
		Electives (PEL)	(L)		(P)	Hours	
ME1012	Mathematical	PCR	3	1	0	4	4
	Methods in						
	Engineering						
Pre-requisite	S	Course Assessmen	nt methods ((Continuous (CT) and en	d assessn	nent
		(EA))					
Engineering	Mathematics in B.	CT+EA					
Tech Level							
Course	CO1: To under	rstand common nur	nerical met	thods and he	ow they ar	e used t	o obtain
Outcomes	approxim	ate solutions.					
	CO2: To derive	numerical methods f	for various i	mathematical	operations	and tasks	, such as
	interpolat	ion, differentiation,	integration	n, the solution	on of line	ar and r	nonlinear
	equations	, and the solution of	differential	equations.	• 1 .1	1	
	CO3: To analyz	e and evaluate the ac	$\frac{1}{5}$ curacy of c	ommon nume	erical metho	ods.	**
т :		• 1/	lopics	· • ·			Hours
Topics	Solution of line	ar simultaneous equa	ations, matr	1x Inversion	- f	c	6
Covered	Solution of non	-linear equation of o	ne variable	and solution	of system o	T	0
	Internolation or	intaneous equation					4
	Numerical diff	reactive multiple	rotion				4
	Solution of ord	inory differential equ	ations and	solution of no	rtial difford	ntial	4
	equations	inary unierentiar equ	auons and	solution of pa		innai	4
	Discrete and Fa	st Fourier transform	ation				5
	Analysis of Eig	gen value problems					4
	Application to	different types of Bo	undary valu	ie, Initial valu	e and Eiger	n	4
	value problems						
	Brief discussion	n on software for nur	merical solu	ition			2
Text Books,	Text Books:						
and/or	1. Advanced Eng	1. Advanced Engineering Mathematics, E. Kreyszig					
reference	2. Numerical Me	nerical Methods for Scientist and Engineers, R. W. Hamming					
material	3. Applied Math	ematics for Engineer	s and Physi	cists By Pipe	s and Harvi	.11	
	Reference Book	s:					
	1. Introduction	to Numerical Analy	sis, F. B. H	ildebrand			
	2. Fundamentals	of Engineering Nun	nerical analy	ysis, P. Moin			

Course Code Title of the course (PCR)/ Electives (PEL) Total (L) Total Total (L) Credit Total (L) Credit Total (L) Credit Total (L) Credit Total Hours Total Hours Total Hours Total Hours Credit Total Hours Credit Total Hours Credit Total Hours Credit Total Hours Course Course Course Assessment methods (Continuous (CT) and end assessment (EA)) Course Course CO2: To understand the basic concepts and principles of Heat and Mass Transfer CO2: To learn the basics of heat and mass transfer CO3: To learn about forced and natural convections and heat transfer. CO3: To learn about forced and natural convections and heat transfer. CO4: To Introduce physics of turbulent models. Total Heat and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate. (Basius solution), Hows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow orer an isothermal flat plate. flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flow with pressure gradient (vo	Department of Mechanical Engineering							
Code (PCR)/ Electives (PEL) Leture (T) Turonial (T) Practical (T) Total Hours ME1013 CONVECTIVE HEATTRANSFER AND MASS PCR 3 1 0 4 4 Pre-requisites TRANSFER Course Assessment methods (Continuous (CT) and end assessment (EA)) CONVECTIVE (EA) 4 4 Pre-requisites Course Assessment methods (Continuous (CT) and end assessment (EA)) COI: To understand the basic concepts and principles of Heat and Mass Transfer Outcomes • CO2: To understand the basic concepts and principles of Heat and Mass Transfer • CO2: To learn the basics of heat and mass transfer • CO2: To learn the basics of heat and mass transfer • CO3: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. 1. Governing Equations: Continuity, Momentum and Energy Equations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions, and flow with transpiration, (b) Integral method solutions for flow over an isothermal flar plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (Von Karnan-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow with pressure gradient (Von Karnan-Pohlhausen method). (14)	Course	Title of the course	Program Core	Total Nu	mber of cor	ntact hours		Credit
ME1013 CONVECTIVE INTRANSFER PCR 3 1 0 4 4 AND MASS TRANSFER Course Assessment methods (Continuous (CT) and end assessment (EA)) Course Assessment methods (Continuous (CT) and end assessment (EA)) MEC 304 (Engineering Thermodynamics) and MEC 403 (Heat and Mass Transfer) CT+EA Course Outcomes • CO1: To understand the basic concepts and principles of Heat and Mass Transfer • CO2: To learn the basics of heat and mass transfer • CO3: To learn about forced and natural convections and heat transfer. • CO3: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. Topics Covered 1. Governing Equations: Continuity, Momentum and Energy Equations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution, Hows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate. (Iat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow whrough channels and circular pipe. Fully developed forced convection in the thrance region of ducts and channels (Graet solution), heat transfer in the combined entrance region (b) Integral method for internal flows wi	Code		(PCR) /	Lecture	Tutorial	Practical	Total	
ME1013 CONVECTIVE HART TRANSFER AND MASS PCR 3 1 0 4 4 Pre-requisites Course Assessment methods (Continuous (CT) and end assessment (EA)) COURSE Course Assessment methods (Continuous (CT) and end assessment (EA)) MEC 304 (Engineering Thermodynamics) and MEC CT+EA CT+EA 403 (Heat and Mass Transfer) CO2: To understand the basic concepts and principles of Heat and Mass Transfer Outcomes • CO2: To learn the basics of heat and mass transfer • CO3: To learn about forced and natural convections and heat transfer. • CO3: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. Topics 1. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe. Fully developed forced convection, an pipes with different wall boundary conditions			Electives (PEL)	(L)	(T)	(P)	Hours	
IEAT TRANSFER TRANSFER Course Assessment methods (Continuous (CT) and end assessment (EA)) Pre-requisites Course Assessment methods (Continuous (CT) and end assessment (EA)) MEC 304 (Engineering Thermodynamics) and MEC 403 (Heat and Mass Transfer) CT+EA Course Ourcomes • CO1: To understand the basic concepts and principles of Heat and Mass Transfer • CO2: To learn the basics of heat and mass transfer • CO3: To learn about forced and natural convections and heat transfer. • CO3: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. Topics 1. Governing Equations: Continuity, Momentum and Energy Equations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions, for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Gratez solution), heat transfer in the combineac region, (b) Integral method for internal flows with different wall boundary conditions, (10) 4. Natural Convection heat trans	ME1013	CONVECTIVE	PCR	3	1	0	4	4
AND MASS TRANSFER Course Assessment methods (Continuous (CT) and end assessment (EA)) MEC 304 (Engineering Thermodynamics) and MEC 403 (Heat and Mass Transfer) CT+EA Course Outcomes • CO1: To understand the basic concepts and principles of Heat and Mass Transfer • CO2: To learn the basics of heat and mass transfer • CO2: To learn about forced and natural convections and heat transfer. • CO2: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. Topics Covered 1. Governing Equations: Continuity, Momentum and Energy Equations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plata, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (ron Karman-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe. Fully developed forced convection in pipes with different wall boundary conditions. Forced convection in the thermal entrance region, (b) Integral method for internal flow swith different wall boundary conditions. (10) 4. Natural Convection heat transfer: Governing equations for flatant alc onvection in enclosures, mixed convection flat plate, effects of inclination, Natural convection in enclosures, mixed convection heat transfer solutions, Integral method		HEAT TRANSFER						
IRANSFER Course Assessment methods (Continuous (CT) and end assessment (EA)) MEC 304 (Engineering Thermodynamics) and MEC 403 (Heat and Mass Transfer) CT+EA Course Outcomes • CO1: To understand the basic concepts and principles of Heat and Mass Transfer • CO2: To learn the basics of heat and mass transfer • CO2: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. • CO4: To Introduce physics of turbulent models. Topics Covered 1. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Palkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrace region, (b) Integral method for internal flows with different wall boundary conditions. (10) 4. Natural Convection heat transfer: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Similarity solutions for Laminar flow past a verti		AND MASS						
Pre-requisites Course Assessment methods (Continuous (C1) and end assessment (EA)) MEC 304 (Engineering Thermodynamics) and MEC 403 (Heat and Mass Transfer) CT+EA Course Outcomes • CO1: To understand the basic concepts and principles of Heat and Mass Transfer • CO2: To learn the basics of heat and mass transfer • CO3: To learn about forced and natural convections and heat transfer. • CO3: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. Topics 1. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Ecker solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe. Fully developed forced convection in pipes with different wall boundary conditions. Forced convection in thermal entrance region of ducts and channels (Graetz solution), heat transfer in the combined entrance region, (b) Integral method for internal flows with different wall boundary conditions. Integral method for antural convection for natural convection, Roussinesq approximation, Dimensional Analysis, Similarity solutions for Laminar fl	Due un and	TRANSFER					. 1	
MEC 304 (Engineering Thermodynamics) and MEC 403 (Heat and Mass Transfer) CT+EA Course Outcomes • CO1: To understand the basic concepts and principles of Heat and Mass Transfer • CO2: To learn the basics of heat and mass transfer • CO2: To learn the basics of turbulent models. Topics Covered • CO4: To Introduce physics of turbulent models. Topics Covered • CO4: To Introduce physics of turbulent models. 1. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region, (b) Integral method for internal flows with different wall boundary conditions. (10) 4. Natural Convection heat transfer: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Similarity solutions, for Laminar flow past a vertical plate with constant wall temperature and heat flux conditions, Integral method for natural convection heat pransfer in atural c	Pre-requis	ites	(EA))	nt methods (Continuous	s (CT) and er	id assessin	ient
Thermodynamics) and MEC 403 (Heat and Mass Transfer) Course • COI: To understand the basic concepts and principles of Heat and Mass Transfer Outcomes • CO2: To learn the basics of heat and mass transfer • CO2: To learn about forced and natural convections and heat transfer. • CO3: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. Topics Covered 1. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe. Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrace region of ducts and channels (Graetz solution), heat transfer in the combined entrance region, (b) Integral method for internal flows with different wall boundary conditions. (10) 4. Natural Convection heat transfer: Governing equations	MEC 304	(Engineering	CT+EA					
403 (Heat and Mass Transfer) Course Outcomes • CO1: To understand the basic concepts and principles of Heat and Mass Transfer • CO2: To learn the basics of heat and mass transfer • CO2: To learn about forced and natural convections and heat transfer. • CO3: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. Topics 1. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Graetz solution), heat transfer in the combined entrance region, (b) Integral method for internal flow swith different and heat flux conditions, Integral method for internal flow past a vertical plate effects of inclination, Natural convection heat transfer: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Similarity solutions for Laminar flow past a vertical plate effects of inclination, Natural convection flow past vertical	Thermody	namics) and MEC						
Course Outcomes • CO1: To understand the basic concepts and principles of Heat and Mass Transfer • CO2: To learn the basics of heat and mass transfer • CO2: To learn about forced and natural convections and heat transfer. • CO3: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. Topics 1. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region, (b) Integral method for internal flows with different wall boundary conditions. (10) 4. Natural Convection heat transfer: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Similarity solutions for Laminar flow past a vertical plate with constant wall temperature and heat flux conditions, Integral method for natural convection flow past vertical plate and in enclosures, Physical characteristics and dynamics of natural convection, Grashoff's number, modified momentum equation for natural co	403 (Heat	and Mass Transfer)						
Outcomes • CO2: To learn the basics of heat and mass transfer • CO3: To learn about forced and natural convections and heat transfer. • CO4: To Introduce physics of turbulent models. Topics Covered 1. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow orn isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Graetz solution), heat transfer: Governing equations for natural convection, Boussinesq approximation, Di mensional Analysis, Similarity solutions for Laminar flow past a vertical plate with constant wall temperature and heat flux conditions, Integral method for natural convection flow past vertical plate, effects of inclination, Natural convection in enclosures, mixed convection for natural convection, Grashoff's number, modified momentum equation for natural convection, Grashoff's number, modified momentum equation for natural convection flow past vertical plate as well as inside enclosure (14) 5. Condensati	Course	CO1: To und	lerstand the basic co	ncepts and p	principles of	f Heat and M	lass Trans	fer
 CO3: To learn about forced and natural convections and heat transfer. CO4: To Introduce physics of turbulent models. Topics Covered 1. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Graetz solution), heat transfer in the combined entrance region, (b) Integral method for internal flows with different wall boundary conditions. (10) 4. Natural Convection heat transfer: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Similarity solutions for Laminar flow past a vertical plate with constant wall temperature and heat flux conditions, Integral method for natural convection flow past vertical plate, effects of inclination, Natural convection in enclosures, mixed convection heat transfer past vertical plate and in enclosures. Physical characteristics and dynamics of inatural convection, Grashoff's number, modified momentum equation for natural convection boundary layer, natural convection around inclined and horizontal flat plate as well as inside enclosure (14) 5. Condensation and Boiling: physical characteristics and different modes of condensation, a	Outcomes	• CO2: To lea	rn the basics of heat	and mass tr	ansfer			
 CO3. To rearr about forced and natural convections and near transfer. CO4: To Introduce physics of turbulent models. I. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). (14) Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region, (b) Integral method for internal flows with different wall boundary conditions. (10) Natural Convection heat transfer: Governing equations for Laminar flow past a vertical plate with constant wall temperature and heat flux conditions, Integral method for natural convection flow past vertical plate with constant wall temperature and heat flux conditions, Kutural convection in enclosures, mixed convection heat transfer past vertical plate and in enclosures, mixed convection heat transfer past vertical plate and in enclosures. Physical characteristics and dynamics of natural convection, Grashoff's anumber, modified momentum equation for natural convection boundary layer, natural convection and Boiling; physical characteristics and different modes of condensation, Nusselt's analysis for film wise condensation over a vertical flat plate, rate of condensation, average heat transfer coefficient and Nusselt number calculations, condensation, average heat transfer coefficient and Nusse			rn about forced and	natural con	vactions and	l haat transfa	r	
 CO4: To Introduce physics of turbulent models. Topics Covered 1. Governing Equations: Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy. (6) 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). (14) 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Graetz solution), heat transfer in the combined entrance region, (b) Integral method for internal flows with different wall boundary conditions. (10) 4. Natural Convection heat transfer: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Similarity solutions for Laminar flow past a vertical plate with constant wall temperature and heat flux conditions, Integral method for natural convection flow past vertical plate, effects of inclination, Natural convection in enclosures, mixed convection heat transfer past vertical plate and in enclosures. Physical characteristics and dynamics of natural convection, Grashoff's number, modified momentum equation for natural convection boundary layer, natural convection around inclined and horizontal flat plate as well as inside enclosure (14) 5. Condensation and Boiling: physical characteristics and different modes of condensation, Nusselt's analysis for film wise condensation over a vertical flat plate, rate of con		• CO3. 10 lea			all all	i neat transfe	1.	
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 4. Natural Convection heat transfer: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Similarity solutions for Laminar flow past a vertical plate with constant wall temperature and heat flux conditions, Integral method for natural convection flow past vertical plate, effects of inclination, Natural convection in enclosures, mixed convection heat transfer past vertical plate and in enclosures. Physical characteristics and dynamics of natural convection, Grashoff's number, modified momentum equation for natural convection boundary layer, natural convection around inclined and horizontal flat plate as well as inside enclosure (14) 5. Condensation and Boiling: physical characteristics and different modes of condensation, Nusselt's analysis for film wise condensation over a vertical flat plate, rate of condensation, average heat transfer coefficient and Nusselt number calculations, condensation around vertical and horizontal tube and array of tubes,Different modes of Boiling and Nukiyama's pool boiling curve, film boiling, forced convection boiling in tube (8) 6. Mass transfer. (4) 		 2. Laminar External flow and heat transfer: (a) Similarity solutions for flat plate (Bla solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow y transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat p with constant heat flux and with varying surface temperature (Duhamel's method), fl with pressure gradient (von Karman-Pohlhausen method). 3. Laminar internal flow and heat transfer: (a) Exact solutions to N-S equations for f through channels and circular pipe, Fully developed forced convection in pipes y different wall boundary conditions, Forced convection in the thermal entrance region, Integral method for internal flows with different wall boundary conditi (10) 					(Blasius low with flat plate d), flows (14) for flow pes with egion of gion, (b) nditions.	
Nusselt's analysis for film wise condensation over a vertical flat plate, rate of condensation, average heat transfer coefficient and Nusselt number calculations, condensation around vertical and horizontal tube and array of tubes,Different modes of Boiling and Nukiyama's pool boiling curve, film boiling, forced convection boiling in tube (8) 6. Mass transfer. (4)	 4. Natural Convection heat transfer: Governing equations for natural of Boussinesq approximation, Dimensional Analysis, Similarity solutions for Lar past a vertical plate with constant wall temperature and heat flux condition method for natural convection flow past vertical plate, effects of inclinatio convection in enclosures, mixed convection heat transfer past vertical plate enclosures. Physical characteristics and dynamics of natural convection, number, modified momentum equation for natural convection boundary lay convection around inclined and horizontal flat plate as well as inside (14) 					atural con for Lami onditions, aclination, ical plate ection, Gr ary layer, inside e	nvection, nar flow Integral Natural and in rashoff's , natural enclosure	
6. Mass transfer. (4)	5. Condensation and Boiling: physical characteristics and different modes of conde Nusselt's analysis for film wise condensation over a vertical flat plate, rate of conde average heat transfer coefficient and Nusselt number calculations, condensation vertical and horizontal tube and array of tubes,Different modes of Boiling and Nuk pool boiling curve, film boiling, forced convection boiling in tube						ensation, ensation, n around kiyama's (8)	
		6. Mass transfer.						(4)

Text Books,	Text Books:
and/or	1. Convection Heat Transfer – A. Bejan
reference	2. Title: Convective Heat Transfer Author: S. Kakac and Y. Yener
material	3. Convective Heat Transfer L.C. Burmeister
	4. Principles of Convective Heat Transfer – M. Kaviany
	Reference Books:
	1. Convective Heat and Mass Transfer – Kays and Crawford
	2. Convective Heat and Mass Transfer – S. M. Ghiaasiaan
	3. Heat Convection – L. M. Jiji
	4. Title: Fundamentals of Heat and Mass Transfer, Author: F.P. Incropera and D. Dewitt
	5. Title: Boundary Layer Theory, Author: H. Schlichting and K. Gersten

	Department of Mechanical Engineering						
Course 7	Fitle of the course	Program Core	Total Nu	mber of con	tact hours		Credit
Code		(PCR) /	Lecture	Tutorial	Practical	Total	
		Electives (PEL)	(L)	(T)	(P) [#]	Hours	
ME2011 N	Microfluidics	PCR	3	1	0	4	4
MEC303 Flui	d Mechanics	Course Assessmer	nt methods (Continuous	s evaluation ((CE) and e	end
MEC304 Eng	gineering	assessment (EA))					
Thermodynam	nics						
MEC403Heat	Transfer and						
Mass Transfe	r						
PHC01 Engin	eering Physics						
CYC01 Engir	neering Chemistry						
BTC01 Life S	Science						
NIL		CE+EA					
Course	• CO1: To	learn micro channel	flows with	heat transfe	er.		
Outcomes	• CO2: To	learn Surface Tensic	on Driven F	lows with r	eal life appli	cations.	
	• CO3: To	learn Electrohydrody	ynamics fur	damentals			
	• CO4: To	learn Molecular Dyr	namics Simu	ulations			
Topics	Lec-01 Introducti	on to Microfluidics:	Origin, Def	finition, Be	nefits, Challe	enges, Cor	nmercial
Covered	activities, Physics	s of miniaturization,	Scaling law	vs, Intermol	lecular forces	s, States o	f matter,
	Continuum assum	ption, Governing eq	uations, Co	nstitutive r	elations -1hr.		
	Lec-02 Microflu	idics- Some Applic	cation Exar	nples: Dru	g delivery,	Diagnosti	cs, Bio-
	sensing- 1hr.						
	Lec-03 Equations	of Conservation-1h	r.				
	Lec-04-05 Navier	Stokes Equation-2	nr.				
	Lec-07-08 Energy	/ Equation-2 hr.	_		~ ~		~ ~
	Lec-09-13 Pressu	re –driven Microflo	ws: Exact s	solutions, C	Couette flow,	, Poiseuill	e flow-5
	hr.	- 1 0.11	1 51				
	Lec-14-16 Some	Examples of Unstea	idy Flows:	Hydraulic 1	resistance an	d Circuit	analysis,
	Straight channel of	of different cross-sec	tions, Chan	nels in serie	es and paralle	el $3 hr.$	m
	Lec-1/-18 Stokes	Drag on a Sphere: S	stokes drag	on a sphere	e, Time-depe	ndent flow	vs, Two-
	phase flows -2 hr.	· · · · · · · · · · · · · · · · · · ·					
	Lec-19-20 Lubric	ation Theory -2 hr.		01		1.11	. 1 . 01
	Lec-21-22 Bound	ary Condition in Flu	nd Mechani	cs - Slip or	No-slip: Ga	s and liqu	id flows,
	Boundary condit	ions, Slip theory,	Iransition	to turbulen	ce, Low Re	e flows,	Entrance
	effects-2 hr.						

	Lec-23-28 Surface Tension Driven Flows: Surface tension and interfacial energy, Young-
	Laplace equation, Contact angle, Capillary length and capillary rise, Interfacial boundary
	conditions, Marangoni effect -6 hr.
	Lec-29-32 Thin Film Dynamics-4 hr.
	Lec-33-34 Lab on a CD-2 hr.
	Lec -35 Introduction to Microfabrication: Materials, Clean room, Silicon crystallography,
	Miller indices. Oxidation, photolithography- mask, spin coating, exposure and
	development, Etching, Bulk and Surface micromachining, Wafer bonding. Polymer
	microfabrication, PMMA/COC/PDMS substrates, micromolding, hot embossing, fluidic
	interconnections1 hr.
	Lec-36-41 Electrokinetics: Electrohydrodynamics fundamentals.
	Electro-osmosis, Debye layer, Thin EDL limit, Ideal electro-osmotic flow, Ideal EOF with
	back pressure, Cascade electro-osmotic micropump, EOF of power-law fluids.
	Electrophoresis of particles, Electrophoretic mobility, Electrophoretic velocity dependence
	on particle size.
	Dielectrophoresis, Induced polarization and DEP, Point dipole in a dielectric fluid, DEP
	force on a dielectric sphere, DEP particle trapping, AC DEP force on a dielectric sphere.
	Electro-capillary effects, Continuous electro-wetting, Direct electro-wetting, Electro-
	wetting on dielectric-/ hr.
	Lec-42 Dispersion-1 nr.
	Lec-45-44 Introduction to Nanoniudics-2 nr.
	Lec-45 Introduction to Molecular Dynamics Simulations-1 nr.
	Lec-40-47 Dio Inicionalaise -2 III.
Taxt Pools	Suggested Text Deckey
and/or	1) Microfluidics - Stéphane Colin
reference	2) Micro, and Nanoscala Eluid Machanics. Transport in Microfluidia Davicas. Prion
material	2) Micro- and Nanoscale Fluid Mechanics, Transport in Micronuluic Devices- Brian Kicke, Cambridge University Device
	Kirby, Cambridge University Press.
	Suggested Reference Books:
	1) Theoretical Microfluidics-Henrik Bruus, Oxford University Press.
	2) Fundamentals and Applications of Microfluidics: Nam- Trung Nguyen and Steven 1.
	 Weieley Advanced Transport Dhanomene: Eluid Mechanics and Convective Transport I
	Gary Leal
1	Oury Loui

Department of Mechanical Engineering							
Course	Title of the course	Program	Total Nu	mber of con	tact hours		Credit
Code		Core (PCR)	Lecture	Tutorial	Practical	Total	
		/ Electives	(L)	(T)	(P)	Hours	
		(PEL)					
ME2012	COMPUTATIONAL	PCR	3	1	0	4	4
	FLUID FLOW &						
	HEAT TRANSFER						
Pre-requisi	tes	Course Assessment methods (Continuous (CT) and end assessment					
		(EA))					
Fluid Mech	anics, Convective Heat	CT+EA					
and Mass T	ransfer, Conduction and						
Radiation, I	Mathematical Methods in						
Engineering							
Course	CO1: To introduce	e the physical a	nd computa	ational aspe	cts of the gov	verning eq	uations
Outcomes	of transport proce	of transport processes					

	M. TECH. IN FLUID MECHANICS AND HEAT TRANSFER
	• CO2: To introduce numerical techniques in fluid flow and heat transfer problems
	• CO3: To introduce the stability of different numerical schemes
	• CO4: To learn different discretization methods of computational fluid dynamics
	• CO5: To learn application of numerical techniques in solving engineering transport processes
Topics Covered	Module I: Introduction to computational fluid dynamics and principles of conservation: continuity equation, Navier-Stokes equation, energy equation and general structure of conservation equations, classification of partial differential equations and physical behaviour (10) Module II: Approximate solutions of differential equations: error minimization principles, variational principles and weighted residual approach, fundamentals of discretization: finite difference, finite volume and finite element methods, grid generation techniques (10) Module III: Boundary condition implementation and discretization of unsteady state problems, important consequences of discretization of time dependent diffusion type problems and stability analysis : consistency, stability and convergence, lax equivalence theorem, grid independent and time independent study, stability analysis of parabolic equations (1-D unsteady state diffusion problems): FTCS (forward time central space) scheme, stability analysis of parabolic equations (1-D unsteady state diffusion problems): CTCS scheme (leap frog scheme), Dufort-Frankel scheme, stability analysis of hyperbolic equations: FTCS, FTFS, FTBS and CTCS schemes, finite difference discretization of 2-D unsteady state diffusion type problems, solution techniques for systems of linear algebraic equations; stream function vorticity approach and primitive variable approach: fractional-step method (projection method), simplified MAC (SMAC) method Module IV: Introduction to finite volume method (FVM) of discretization: Conservative differential form and integral form governing equations of fluid flow, finite volume method for 2-D unsteady state diffusion problems, finite volume method for convection-diffusion problems, solution algorithm for pressure-velocity coupling in steady flows; SIMPLE, SIMPLER and PISO algorithms
Text Books, and/or	Text Books: 1. Computational Fluid Mechanics and Heat Transfer –Anderson, Tannehill, and Pletcher
reference	2. Computational Methods for Fluid Dynamics –Ferziger and Peric
material	3. Computational Techniques For Fluid Dynamics – Fletcher
	4. Fundamentals of Computational Fluid Dynamics – Roache
	S. Computational Fluid Dynamics and Heat Transfer – Gnoshdastidar Reference Books:
	1. An Introduction to Computational Fluid Dynamics: The Finite Volume Method –
	Versteeg and Malalasekera
	2. Numerical Heat transfer and Fluid flow – Patankar

Department of Mechanical Engineering									
Course	Title of the course	Program Core	Total Nu	mber of cor	ntact hours		Credit		
Code		(PCR) /	Lecture	Tutorial	Practical	Total			
		Electives	(L)	(T)	(P)	Hours			
		(PEL)							
ME2013	CONDUCTION	PEL	3	1	0	4	4		
	AND RADIATION								
	HEAT TRANSFER								
Pre-requisi	ites	Course Assessment methods (Continuous (CT) and end assessment							
NEC 205	(CI ' 1) (1 ')	(EA))							
MEC 305	(fluid Mechanics),	CI+EA							
MEC 304	(Engineering								
(Host and Mass Transfor)									
(rical and Mass Transfer)									
• COI. To acquire an idea about conduction transport mechanism									
Outcomes	• CO2. To learn	n the basics of heat	and mass tr	ansfer					
	• 002. 10 louin	i the busies of heat	und muss u	unsier					
	CO3: To learn	n the basic knowled	lge of Black	body radia	tion.				
• CO4: To learn the basic concept of Radiation heat exchange betwe						n real surf	aces.		
					0				
Topics	bics 1Conduction: Steady and unsteady problems and their solutions in Cartesian, cylindrical								
Covered	and spherical coordinates. (6)								
	2One dimensional	steady state situa	tion, concep	pt of therm	al resistance	, critical 1	adius of		
	insulation. Differe	ntial equation of h	eat conduct	tion. Heat g	generation. U	Insteady s	tate heat		
	conduction. Separ	ation of variables	. Duhamel'	s theorem.	Laplace tra	insform. I	Problems		
	involving change of	of phase. Inverse he	eat conduction	on, Micro s	cale heat trar	ister.	(10)		
	3 Fins problems	nin fin temperatur	e distributio	on of nin fi	n The effect	iveness of	nin fin		
	(4)	pin ini, temperatur	e distributio	n or pin in		iveness of	pin iii.		
	4. Numerical solution	tion of conduction	problems:	Basic ideas	s of finite di	fference n	nethod -		
	forward, backward	and central differe	ences – Disc	cretization f	or the unstea	dy heat ec	uation –		
	simple problems.	Basis ideas of the	finite volu	me method	l – applicatio	on to Lap	lace and		
	Poisson equations.						(8)		
		с т і ·		1 5	D '' '				
	5. Properties of Su	irfaces: Introductio	n, Black Bo	ody Radiati	on, Radiative	e propertie	s of real		
	Surfaces.	ngo hotwoon auf	and Introduc	ation Char	a factor Erro	luction of	(10) shans		
	factors Dediction	ange Derweell Sulla	Grav surfee	es anclosur	e racior, Eva	iuation of	(12)		
	7 Gas Radiation I	Introduction Rear's	law Emice	Δ ivity and Δ	u hsorntivity o	f gases an	(12) d gas		
	mixtures Radiation	n and climate	, iaw, Liinss	i i i y and A	osorpuvity 0	i Subeb all	(6)		
Text Book	s, Text Books:						(0)		
and/or	1. Title: Conducti	on and Radiation A	uthor: K. N	Iuralidhar,					
reference	2. Title: Heat Con	duction Author: Sa	adikKakac a	and Yaman	Yener				
material	3. Thermal Radiat	ion Heat Transfer -	- Sigel R and	d Howell J					
	4. Radiative Heat	Transfer - Michael	F Modest						
	Reference Books:								
	1. Title: Heat Conduction Author: Hahn, D. W. and Ozisik M. N.,								

Department of Mechanical Engineering									
Course	Title of the course	Program Core	Total Nu	mber of cor	ntact hours		Credit		
Code		(PCR) /	Lecture	Tutorial	Practical	Total			
		Electives (PEL)	(L)	(T)	(P)	Hours			
ME2014	Compressible	PEL	3	1	0	4	4		
	Flow								
Pre-requis	ites	Course Assessmen	Course Assessment methods (Continuous (CT) and end assessment						
		(EA))							
Fluid Mec	hanics and	CT+EA							
Thermody	namics studied in								
B.Tech/BE	E Course		~						
Course	• CO1: To	learn compressible f	lows with c	onstant enti	ropy only, wi	ith friction	only		
Outcomes	and with	heat transfer only.							
	- CO2 T	1	1.1' 01	1 10	1.1 1.4	C1 '.1	11.0		
	• CO2: 10	learn Normal shock,	, oblique Sh	ock and Pra	anati-Meyer	riow with	real life		
	application	ons.							
• CO3: To learn how to design the supersonic perofoils									
	• CO3. 10	learn now to design	the superso		.5.				
 Topics Covered 1-D gas dynamics: Basic governing equations, Flow with Variable area without normal shock and with normal shock. Fanno flow and Ray flow. Solution of problems using gas table. 1-D wave motion: wave propagation – simple and finite waves, 2-D w governing equations. Moving Normal shocks and oblique shocks: Normal vers superposition for moving Normal shock and tangential velocity superposition oblique shock, oblique shock analysis for perfect gas, oblique shock table charts.Prandtl-Meyer flow: Isentropic turn (either around expansio compression corner) from infinitesimal shocks, Mach waves, Prandtl-Meyer analysis, Prandtl-Meyer function, overexpanded and underexpanded no boundary conditions for flow direction and pressure, shock diamond, super aerofoils, Working of supersonic wind tunnel. 24 If Correlation of Fanno flow, Rayleigh flow, and a normal s Linearized flow: subsonic flow–Goethert's and Prandtl-Glauert hodograph methods, supersonic thin airfoils, supersonic 2-D air application of oblique shock and Prandtl-Meyer to calculate Lift and on supersonic aerofoils. 							rea duct ayleigh 16 waves, velocity ition for able and sion or yer flow nozzles, personic 24 hrs shock t rules, airfoils, nd Drag 16		
Text Book	s, Text Books:	domontals of any i-	omiac DD	7uolean e	Occor Dible	1 7			
reference	I. FUI	oolee	iannes -K.D	. Lucker &	Uscal Divia	12.			
material		UUKS.		a of Course		Elem A	TT		
material	I. The	Dynamics and Ther	moaynamic	s of Compr	essible Fluid	FIOW- A.	н.		
	Shapiro.								

SESSIONAL/LAB

	Γ	Department of Mecha	anical Engin	neering				
Course	Title of the course	Program Core	Total Nu	mber of con	tact hours		Credit	
Code		(PCR) /	Lecture	Tutorial	Practical	Total		
		Electives (PEL)	(L)	(T)	(P)	Hours		
ME 1061	Thermo-Fluids	PCR	0	0	4	4	2	
	Laboratory							
Pre-requisit	ies							
Fluid Mech	anics, Convective	CT+EA						
Heat and M	lass Iransfer,							
Conduction		rn tha fundamentals	of or parime	ntal tachni				
Outcomes	 CO3: To perform experimental validation of theory in Fluid Mechanics and Heat Transfer CO2: To learn the design and analysis of experiments 							
Tonics								
Covered	 To mean sections (4) To mean sections of a sections of a To detern conduction a To detern flow rate variable To means for differ To study in a Diff To detern microcha To detern with the micro sin 	asure the wall static pressure and pressure distribution at different of a straight duct and curved duct for incompressible flow of air. Isure the wall static pressure and pressure distribution at different a straight diffuser for incompressible flow of air. (4) ermine the thermal conductivity of brass using linear and radial apparatus. (4) ermination of convective heat transfer coefficient and actual mass te of air for forced flow of air through unknown specimen under e condition.(4) sure the boundary layer thickness at various locations on a flat plate erent Reynolds numbers with incompressible flow of air. (4) y of Heat Transfer Enhancement with the Application of Nanofluids ferentially Heated Cavity. (4) rmine the average heat transfer coefficient and multiple nannels heat sink. rmine the microchannel's heat transfer coefficient and pressure drop e different hydraulic diameter, aspect ratio, and channel numbers of ink						
Text Books and/or reference material	, Text Books: 1. Spring 2. Instrur 3. Therm Reference Books 1. Experin	inger Handbook of Experimental Fluid Mechanics—Tropea and Yarin trumentation, Measurements, and Experiments in FluidsRathakrishnan ermal and Flow MeasurementsTW. Lee boks: perimental Methods for EngineersHolman						

	Department of Mechanical Engineering								
Course	Title of the course	Program Core	Total Nu	mber of cor	tact hours		Credit		
Code		(PCR) /	Lecture	Tutorial	Practical	Total			
		Electives (PEL)	(L)	(T)	(P)	Hours			
ME 1062	Numerical	PCR	0	0	4	4	2		
	Simulation								
	Laboratory								
Pre-requisit	tes								
Basic know	ledge in Numerical	CT+EA							
Methods	GO1								
Course	• CO1: To wr	rite different numeric	al methods	related to en	ngineering pi	oblems.			
Outcomes		riting Computer prod	romming to	colvo vorio	us anginagri	na probla	ma hu		
	• CO2: 10 w	riting Computer prog	granning to	solve vario	bus engineeri	ing proble	ins by		
	numerical m	nethods.							
Topics	1 Programmin	a using high level	languaga (l	C/C + For	tron/MATI	$(\mathbf{A}\mathbf{B})$			
Covered 2. Computer programming for solving linear simultaneous equations, non li						n lingar			
0010100	2. Computer p	orogramming for s	orving mix	ai siinuna	neous equa		II-IIICai		
	3 Numerical d	lifferentiation and i	ntagration	(8)					
	J. Numerical d	ordinary different	ial equation.	(0)	lution of n	artial diff	Forantial		
	+. Solution of	ordinary unreferit	iai equatio	ins and so	fution of p		cicittai		
	5 Eigen volue	probleme Rounder	ry voluo. Ir	vitial value	problems (4)			
	5. Eigen value	assigned by the real	spective ter	ntial value	problems.(*	+)			
Text Books	Text Booker	assigned by the let	specifie ice	ueners.(+)					
and/or	1 Nume	rical Methods By B	S Grewal						
reference	2 Applie	ed Numerical Metho	ds for Digit:	al Computat	ion By M I	James G	ЪM		
material	Smith	and J. C. Wolford	us for Digit	a computa		. Junes, C			
	3. Nume	rical Methods for En	gineers By	S.C. Chapra	and R. P. C	anale			
	Reference Book	S	6 <i>-</i> j						
	1. Numer	rical Methods for Eng	gineers By I	D. V. Griffit	hs and I. M.	Smith			
	2. Numer	rical Recipes By W.	H. Press, S.	A. Teukols	ky, W. T. Ve	tterling an	d B. P.		
	Flanne	ery.			÷	e e			
	3. Compu	uter aided Mechanica	anical Design and Analysis By V. Ramamurti						
	_	5. Computer alaca meenamear Design and Philappin Dy + Ramamarti							

Department of Mechanical Engineering							
Course Code	Title of the	Program Core	Total Nur	mber of con	tact hours		Credit
	course	(PCR) /	Lecture	Tutorial	Practical	Total	
		Electives (PEL)	(L)	(T)	(P)	Hours	
ME 2061	CFD	PCR	0	0	4	4	2
	Laboratory						
Pre-requisites							
Basic knowledge in fluid		CT+EA					
dynamics, hear	t transfer and						
numerical met	hods						
Course	CO1: To write	ting computer progr	amming in f	finite differ	ence method	(FDM) us	sing
Outcomes	high level la	anguage					
	0	00					
	• CO2: To L	earn the use of com	mercially av	vailable CF	D software to	o solve so	me basic
	fluid dynamics and heat transfer problems						
		nes and near transfer problems					
<u> </u>	•						Pag

Topics	Part I: Code development in finite difference/ finite volume methods using							
Covered	Matlab/C++ as interface(20)							
	 1-D steady heat conduction problem (determine the temperature distribution along the axis of a fin) 							
	 2-D steady heat conduction problem (determine the temperature distribution on a rectangular slab) 							
	 1-D/2-D unsteady heat conduction problem (determine the transient temperature distribution along the axis of a fin/on a rectangular slab) Lid-driven cavity flow using stream-function vorticity technique 							
	Part II: Developing Solution of CFD problems using ANSYS-FLUENT/ COMSOL Software (20) Axisymmetric flow through a circular pipe under isothermal condition							
	 Axisymmetric flow through a circular pipe under non-isothermal condition 							
	 Blasius flow over a flat plate 							
	 Flow past a solid, circular cylinder (Re: 30-70) 							
	 Natural convection along a vertical flat plate 							
Text Books, and/or reference material	 Text Books: 1. Numerical heat transfer and fluid flow. CRC press. By Patankar, S. 2. Computational fluid dynamics: the finite volume method. Harlow, England: Longman Scientific & Technical. By Versteeg, H. K., and W. Malalasekera. 3. ANSYS fluent theory guide 15.0. Reference Books 							
	 Computational fluid dynamics. New York: McGraw-Hill. By Anderson, J. D. Computational methods for fluid dynamics. Springer Science & Business Media. By Ferziger, J. H. and Peric, M. 							

Department of Mechanical Engineering									
Course	Title of	Program	Total Nu	mber of cor	ntact hours		Credit		
Code	the	Core (PCR)	Lecture	Tutorial	Practical	Total			
	course	/	(L)	(T)	(P)	Hours			
		Electives							
		(PEL)							
ME 2062	Mini Project	PCR	0	0	0	6	3		
	with Seminar		v	Ū	v	Ũ	e		
Pre-requisites	5	Course Assess	nent metho	ds (Continu	ious (CT) a	and end a	ssessment		
		(EA)							
NA		CT+EA	CT+EA						
Course	CO1: To be a	able to conduct re	eview of li	terature to a	arrive at se	lected ad	dvanced		
Outcomes	topic for proje	ect work.							
	CO2: Ability	to interpret ideas	and though	nts into prac	tice in a pr	oject.			
	CO3: Ability	to analyze the gai	between t	heoretical a	ind practica	al knowle	edge.		
	CO4· To be a	ble to write and r	resent a te	chnical repo	rt with sui	table cor	clusion		
		tional standards	nesent a tes	ennieur repo	nt with Sui		leidsion		
			. 1 . 1 . 1		6.4	, .			
	CO5: To be a	CO5: To be able to discuss and depend the outcome of the report in a seminar							
Topics	Project as dec	ided based on lite	erature surv	ey with con	sultation v	vith the			
Covered	superv	visor							

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Department of Mechanical Engineering									
Course	Title of the	Program	Total Nu	mber of cor	ntact hours		Credit		
Code	course	Core	Lecture Tutorial Practical Total						
		(PCR) /	(L)	(T)	(P)	Hours			
		Electives							
		(PEL)							
ME 3061	DISSERTATION - I	PCR 0 0 24 24 10							
Pre-requisite	28	Course Asse assessment (essment me (EA))	thods (Cont	inuous (C	Γ) and en	nd		
NA		CT+EA	<u> </u>						
Course Outcomes	Course CO1: Ability to interpret ideas and thoughts into practice in a project. CO2: Ability to analyze the gap between theoretical and practical knowledge. CO3: Ability to compose technical presentation in the conferences. CO4: Ability to prepare for publishing papers in journals. CO5: Ability to propose for the patent rights for the projects.								
Topics	Project as decide	Project as decided based on literature survey with consultation with the							
Covered	supervisor								

Department of Mechanical Engineering									
Course	Title of	Program Core	Total Nu	mber of cor	ntact hours		Credit		
Code	the	(PCR) /	Lecture	Tutorial	Practical	Total			
	course	Electives	(L)	(T)	(P)	Hours			
		(PEL)							
ME 3062	Seminar	PCR	0	0	4	4	2		
	(Non		v	U	т	-	2		
	Project)								
Pre-requisit	es	Course Assessment methods (Continuous (CT) and end assessment							
		(EA))	(EA))						
NA		CT+EA							
Course	CO1: To be	able to conduct revi	iew of liter	ature to arri	ve at select	ted advai	nced topic		
Outcomes	for ser	ninar.					_		
	CO2: To be	able to summaries t	the concept	of the chos	en topic sy	stematic	ally after		
	consid	erable study of the	content fro	m primary a	as well as s	econdary	y sources		
	CO3: To be	able to write and pr	resent a tech	hnical repor	t with suita	able conc	clusion as		
	per int	ernational standards	s	_					
	CO4: To be	able to discuss and	depend the	outcome of	f the report	in a sen	ninar		
Topics	Topics decid	led by consultation	with the su	pervisor					
Covered									

Department of Mechanical Engineering							
Course	Title of the	Program	Total Nu	mber of cor	ntact hours		Credit
Code	course	Core	Lecture	Tutorial	Practical	Total	
		(PCR) /	(L)	(T)	(P)	Hours	
		Electives					
		(PEL)					
ME 4061	DISSERTATIO	PCR	0	0	24	24	14
	N - II /	ren	Ū	Ū			
	INDUSTRIAL						
	PROJECT						
Pre-requisite	Course Assess	Course Assessment methods (Continuous (CT) and end assessment					
		(EA))					
NA		CT+EA					
Course	CO1: Ability to	interpret ideas a	nd thought	s into practi	ce in a pro	ject.	
Outcomes	CO2: Ability to	analyze the gap	between th	eoretical an	d practical	knowled	lge.
	CO3: Ability to	compose technic	cal presenta	tion in the	conference	es.	
	CO4: Ability to	prepare for publ	ishing pape	ers in journa	als.		
	CO5: Ability to	propose for the	patent right	s for the pro	ojects.		
Topics	Project as decid	ed based on liter	ature surve	y with cons	ultation wi	ith the	
Covered	supervisor			-			

Department of Mechanical Engineering									
Course	Title of	Program	Total Nu	Total Number of contact hours C					
Code	the	Core (PCR)	Lecture	Tutorial	Practical	Total			
	course	/	(L)	(T)	(P)	Hours			
		Electives							
		(PEL)							
ME 4062	Project	рср	0	0	1	4	2		
	Seminar	ICK	U	U	-	4	2		
Pre-requisit	es	Course Assessm	ent methods (Continuous (CT) and end assessment						
1		(EA))							
NA		CT+EA							
Course	CO1: Ability	to assess knowled	ge in the su	ubject and th	ne project.				
Outcomes	CO2: Ability	to integrate techni	cal questio	n through a	ll the years	s of study	<i>.</i>		
	CO3: Ability	to express and cor	nmunicate		-	•			

Specialization Elective Subjects

	Ι	Department of Mecha	anical Engir	neering					
Course	Title of the course	Program Core	Total Nu	mber of cor	ntact hours		Credit		
Code		(PCR) /	Lecture	Tutorial	Practical	Total			
		Electives (PEL)	(L)	(T)	(P)	Hours			
ME9041	Experimental	PEL	3	0	0	3	3		
	Methods in								
	Thermal Science								
Pre-requisi	ites	Course Assessment methods (Continuous (CT) and end assessment							
		(EA))							
Fluid Mec	hanics,	CT+EA							
Thermody	namics and Heat								
Transfer in	B.Tech/BE Course								
Course	• CO1: To acqu	ire an idea about ba	sic concepts	s of measure	ements				
Outcomes	CO2: To learn	n the basics of data a	cquisition a	nd data ana	lysis				
	• CO3: To learn the measurement techniques for pressure, temperature, flow, velocity								
	etc.								
• CO4: To learn the fundamentals of wind tunnel measurements.									
Topics	• Basic concepts: Calibration, Standards, Dynamic measurement, System response								
Covered	Covered and Fourier analysis, Distortion, Experiment planning (6)								
	Data ana	alysis: Error analysis	, Uncertaint	y analysis,	Statistical an	alysis, Gr	aphical		
	analysis	and curve fitting, M	ultivariable	regression,	Goodness of	f fit (7)	^		
	Flow me	easurement and Flow	-Visualizat	ion method	s (5)				
	Measure	ments of thermo-flu	id-dynamic	variables: p	pressure, tem	perature, v	velocity,		
	etc. (6)		•			•			
	Measure	ments of thermal-an	d-transport-	-property: v	iscosity, ther	mal condu	ictivity,		
	diffusion	n coefficient, pH, hu	midity, etc.	(4)	-				
	Calorim	etry (1)							
	Convect	ion heat-transfer me	asurements	and various	heat-flux m	eters (2)			
	Measure	ment of thermal rad	iation, emis	sivity, refle	ctivity and tr	ansmissiv	ity,		
	Measure	ments of solar radia	tion, Detect	ion of nucle	ear radiation ((5)			
	• Wind tu	nnel: introduction, ir	nstrumentati	on and cali	bration of wi	nd tunnels	(4)		
Text Book	s, Text Books:	,							
and/or	1. Experimenta	l Methods for Engin	eers – J. P.	Holman					
reference	2. Instrumentat	tion, measurements a	and experim	ents in Flui	ds by E. Rath	nakrishnar	l		
material			*		-				
	Reference Books	s:							
	1. Handbook of	1. Handbook of experimental fluid mechanics, Tropea et al.							
	2. Measurement	systems-applicatio	tion and design, Doebelin, E. O.						
1	3. Handbook of	3. Handbook of heat transfer. Rohsenow et al.							

Department of Mechanical Engineering										
Course	Title of the course	Program Core	Total Nu	mber of cor	tact hours		Credit			
Code		(PCR) /	Lecture	Tutorial	Practical	Total				
		Electives (PEL)	(L)	(T)	(P)	Hours				
ME9042	Dynamical	PEL	3	0	0	3	3			
	systems									
Pre-requisi	tes	Course Assessmen	Course Assessment methods (Continuous (CT) and end assessment							
		(EA))								
Basics of a	III Engineering,	U1+EA								
Chamiata	cs, Physics,									
Course	, and Biology \bigcirc CO1. To	loom stobility on alve	via of nonlin	a an transia	t mahlama i	n all field				
Outcomes	• CO1: 10	learn Chaos of popl	noor trongic	nt problem	it problems i	n an neius	s.			
Outcomes	• CO2. It	tions FFT Poincare	Mane Lyan	unav expor	s using uyila ants Hanon	mans and	IVIOIS			
	(Difuica Fractals)	uolis, PP1, Follicale	Maps, Lyap	unav expor	ients, menon	maps and				
Topics One- Dimensional Flow: Flows on the line fixed points and stability linear stability re							lity real			
Covered	life problem and	exercises: Flows on	circle. Fixed	d points and	l stability, rea	al life prob	olem and			
	exercises; Bifurc	ations: Types of bifu	rcations, N	ormal form	s of saddle-r	ode, tran	scritical,			
	pitchfork, Super	critical and Subcrition	cal bifurcat	ions,and in	perfect berf	ercations	real life			
	problem and				•	e	exercises			
	13									
	Two -Dimension	nal Flows: Linear s	ystem, Def	finitions an	d examples,	Classific	ation of			
	Linear system, I	Exercises, Phase plan	ie, Phase po	ortraits, Fix	ed points an	d Lineariz	zation of			
	nonlinear system	ns, Exercises, Limit	cycles, Def	inition and	understandi	ng with ex	xamples,			
	Poincare theory,	FFT of time series	data, Exerc	ises, Bifurc	ations of 2-1	D system,	Saddle-			
	node, Transcritic	al and Pitchfork Bif	urcations, H	lopf Bifurca	ations and its	type with	n normal			
	form, Hopf p	oint and fold poi	nts, Hyste	resis zone	, Poincare	map, F	FT and			
	phase portrait, E	xercises				22				
	Chaos: Lorenz	Equations, Properti	es of Lor	enz Equati	ons, Lorenz	a map, E	xploring			
	parameter Space	, Exercises, One-Din	nensional N	Taps, Fixed	points and o	cobwebs,	Contor			
	Sets Dimension	of a self similar	Fractals,	Roy dimer	sion Point	wise Co	, Califor			
	Dimensions Ex	ercises Strange att	ractor Sin	nnlest eva	nnles Henc	m man	Physical			
	examples. Exerc	ises	21	приозе сла	inpres, mente	ni inap,	I Hysical			
Taut D. 1	Tant De la		_ 1							
lext Book	s, I ext BOOKS:	an dynamics and Cha	he by C II	Strogota						
and/or	I. Nollinea Deference Pool		эх бу 5. п. ,	Strogatz						
material	1 Chaos a	o. nd nonlinear dynamia	es hy PC	Hilborn						
material	2 Differen	tial dynamical system	is by I. D. N	Aeiss						
		and aynannear system	15 UY J. D. N	10100						
Text B	ooks:									
1.1	Nonlinear dynamics an	d Chaos by S. H. Stro	ogat Referen	nce						
Books	Books									

- 1. Chaos and nonlinear dynamics by R. C.Hilborn
- 2. Differential dynamical systems by J. D.Meiss

	Department of Mechanical Engineering								
Course	Title of the course	Program Core	Total Nu	mber of con	tact hours		Credit		
Code		(PCR) /	Lecture	Tutorial	Practical	Total			
		Electives (PEL)	(L)	(T)	(P) [#]	Hours			
ME9043	Fundamentals of	PEL	3	0	0	3	3		
	Combustion								
Pre-requisi	tes	Course Assessmen	nt methods	(Continuous	s evaluation	(CE) and ϵ	end		
	- · ·	assessment (EA))	$CE_{\pm}E\Delta$						
MEC304 (Engineering	CE+EA							
MEC303 (Fluid Mechanics)								
MEC403 (Heat and Mass								
Transfer)	front und winds								
Course	• CO1: To unde	rstand the physical r	process invo	lved in com	bustion				
Outcomes		1 5 1							
	• CO2: To be at	ble to model a proces	ss involving	combustion	1.				
	• CO3: To acqu	ire an in-depth idea	about lamin	ar flames.					
	• CO4: To unde	rstand partially pren	nixed flame	S.					
			1 1						
	• COS: To learn the intricacies of turbulent flames.								
Topics Covered	• Review of the	• Review of thermodynamics, Chemical kinetics, Mass transfer definitions: Fick's law (7)							
Covered	• Equations of diffusion equa	conservation of species mass, momentum, and energy; multi-component ation (5)							
	• Schvab-Zel'do	wich formulation, Ra	ankine-Hug	oniot relatio	ons. (5)				
	• Laminar prer ignition and q	nixed flames: Flan uenching. (7)	ne speed,	flammabilit	y limits, fl	ame stab	ilization,		
	• Laminar diffu	sion flames: Burke-S	Schumann p	roblem and	droplet burn	ing. (5)			
	• Partially prem	ixed flames (7)							
	• Turbulent flam	nes (6)							
Text Book and/or	s, <u>Suggested Text</u> 3) Principles of	<u>Books:</u> Combustion – K. K	. Kuo						
reference material	4) An introduct	tion to combustion –	S. R. Turns	5					
	Suggested Refer 4) Combustion	ence Books: physics – C. K. Law	J						

Department of Mechanical Engineering										
Course	Title of the course	Program	Total Nu	mber of cor	ntact hours		Credit			
Code		Core (PCR)	Lecture	Tutorial	Practical	Total				
		/ Electives	(L)	(T)	(P)	Hours				
		(PEL)								
ME9044	Fluid Power Systems	PEL	3	0	0	3	3			
	and Control									
Pre-requise	ites	Course Assessment methods (Continuous (CT) and end assessment								
		(EA))								
Fluid Mec	hanics, Control	CT+EA								
Engineerir	ng									
Course	• CO1: To build up	p concept of hyd	raulic and p	oneumatic p	ower system	and their				
Outcomes	application areas									
	• CO2: To familiar	rise the students	about funct	tioning of se	everal compo	onents of h	ydraulic			
	power system an	d techniques for	dynamic ai	nalysis of th	lose compon	ents.				
	• CO3: To make th	tem able to design	gn hydraulio	c power pac	ck using seve	ral compo	nents			
	for particular app	blication accordi	ng to specii	ic requirem	ents.	1 hardword:				
	• CO4: 10 make the	lem understood	lome procedu	res to contr	of the overal	i nyarauna	2 power			
Topics	Introduction: int	reduction conce	opt of hydro	g out. ulic and pro	oumatic now	or exetom	and			
Covered	their application	advantages and	disadvantao	une and pho	draulic and	on eumatic	circuit			
Covered	fluid flow fundam	entals flow through	uisauvailiag	and condu	it minor loss	$e_{\rm S}$ (5)	circuit,			
	Hydraulic Fluid: density viscosity effective bulk modulus: thermal properties and									
	equation of state:	chemical proper	ties-contam	ination and	filtration ty	mes of hyd	fraulic			
	fluid selection of	hydraulic fluid	(3)	initiation and	i illi ulioli, ty	pes of fige	indunie			
	Hund, Selection of Hydraulic Pump	. Motor and Ac	tuator: typ	es and cons	struction of b	asic hydra	ulic			
	pumps and motor	; rotary and line	ar actuators	-types and c	construction,	dynamics	of			
	hydraulic pumps	and motor. (6)		91	,		-			
	Control Valves:	types of valves a	and their con	nfigurations	and symbol	s, spool va	alves,			
	poppet valve, flap	per nozzle valve	e, functionii	ng of pressu	re relief and	pressure r	educing			
	valves, direction of	control valves an	d pressure	compensate	d flow contr	ol valves a	and their			
	dynamic analysis	(10)								
	Fluid Power Sys	tem and Dynan	nics : basic f	luid power	systems; dyn	amics of v	valves,			
	valve flow charac	teristics, flow fo	orce and spo	ol stiction,	friction in va	lve and ac	ctuators,			
	leakage flow thro	ugh valve and ac	ctuator ; trai	nsmission li	ne dynamics	, actuator				
	dynamics, hydrau	lic accumulator.	(14)							
	Electro-hydrauli	c Servo System	: types of E	HSVs, perr	nanent magn	et torque 1	notor,			
	two stage flapper	nozzle EHSV dy	ynamics wit	th feedback	control, desi	gn and co	ntrol of			
Tout D = 1	eictro-nydraulic s	ervo mechanism	i, stadility a	na trequenc	cy response a	naiysis (10	J)			
1 ext Book	s, 1 ext BOOKS:	Systom by Man	tt U. John V	Wildy and	Song Inc					
anu/or	2 Fundamentals of El	uid Power Cont	in F, JOIII V	on I Comb	sons me. ridge Univer	aity Droop				
material	2. Fundamentals Of Fl 3. Fluid Dower Engine	ering by M C D	or by wall abie McCa	y watton J. Cambridge University Press.						
material	Reference Rooks									
	1 Fluid Power System	ms: modeling simulation and microcomputer control by John Watton								
	Prentice Hall Internat	ational.								
	2. Fluid Power Contr	ol by Blackburn	. J. F. G	Reethof an	d J. L. Shea	rer. New	York.			
	Technology Press of	M. I. T. and Wi	. T. and Wiley.							

	Department of Mechanical Engineering										
Course	Title of the course	Progra	Total Nu	mber of cor	tact hours		Credit				
Code		m Core	Lecture	Tutorial	Practical	Total					
		(PCR) /	(L)	(T)	(P)	Hours					
		Electiv									
		es									
		(PEL)									
ME9045	ADVANCED THEORY	PEL	3	0	0	3	3				
	OF TURBOMACHINERY			(1 1 (0		VTT) 1	1				
Pre-requisit	es	Course Assessment methods (Continuous (C1) and end assessment (FA))									
Enginaaring	Thermodynamics Heat and										
Mass Trans	fer Fluid Mechanics in UG	CITEA									
Programme	ier, i fuld Weenumes in OG										
Course	Acquire knowledge at	out rotody	namic mach	nines for pro	oducing or us	sing powe	r:				
Outcomes	CO1 Details	of axial and	d radial flov	v gas/steam	and hydraul	ic turbines	used				
	for generatin	g electric n	ower	0							
	CO2 Recon c	o chocule p of details of	hvdraulie r	nimne ae ro	todynamic m	achine					
	$= \frac{CO2}{CO2} \operatorname{Recap} C$	of avial fla	w and contr	ifugal com	buynamie in brossor (in ac	mnoricon	with				
	• <u>COS</u> Detalls	UI axial 110	to importor	nugai com	nesson (III CC	mparison	witti				
Taria	tans and blowers) with its importance in aviation industry										
Topics Covered	Introduction: Basic Pri	Definition of a turbo machina. The fundamental laws. The equation of continuity. The									
Covered	first law of thermod	lacinite, 1	The mon	antum equ	ation Th	of continu	law of				
	thermodynamics – entr	rony The fl	hermodynar	nic properti	ies of fluids	compressi	ble flow				
	relations for perfect ga	ses.	liermouynui	ine properti	tes of fluids,	compress					
	Exercise Problems. 4 hours										
	Dimensional Analysis:	Similitude									
	Dimensionality, Simil	itude, Dim	ensionless	Performanc	e variables	and simil	arity for				
	turbo machinery, Com	pressible flow similarity, Specific speed and specific diameter.									
	Exercise Problems.					4 hours					
	Two Dimensional Case	andaar									
	I wo Dimensional Case	cades:	Velocity	triangles N	lean velocit	v and me	an flow				
	direction Blade inlet	angle Rla	de exit and	ulangics, N ole Inlet	flow angle	Fxit flor	w angle				
	Incidence, Deviation.	Camber	angle. De	eflection.	Nominal ind	cidence.	Nominal				
	deviation. Nominal de	flection. St	bace-chord	ratio.	4 hour	s					
	Analysis of cascade for	rces, Lift a	nd drag forc	es, Lift and	drag co-effi	cient					
			-		-	4 hours					
	Incompressible cascad	le analysis,	Lieblein d	iffusion fac	ctor, Pressure	e rise co-	efficient,				
	Diffuser efficiency of	the cascade	and total p	ressure loss	s co-efficient	and their	relation,				
	static pressure rise, bla	de load rati	10.			2.1					
	Exercise Problems.					2 hours					
	Axial Flow Turbines										
	Introduction Velocity	v diagrams	s of the av	kial turbine	stage. Tur	bine stage	e design				
	parameters. Flow coef	ficient. Sta	ge loading	factor. Stag	e reaction. E	Expression	s for the				
	reaction in terms of th	the flow angles. Velocity triangles and Mollier diagrams for $R = 1$									
	0,0.5,1.0, Thermodyna	namics of the axial turbine stage.									
		4 hours									
	Repeating stage turbin	ne, Stage losses and efficiency, Total-to-total efficiency of a									
	tatic efficiency, Enthalpy loss co-efficient for stator and rotor.										
	Exercise Problems.	6 hours									

	M. TECH. IN FLUID MECHANICS AND HEAT TRANSFER
	Radial Flow Turbines:
	Introduction, types, IFR tubines, kinematic and thermodynamic analysis of turbine stage, turbine stage design parameters, nominal design point efficiency, Mach number relations loss coefficient number of blades rotor exit consideration
	9 hours
	Axial flow compressors:
	Introduction, 2-D analysis of compressor stage, kinematic and thermodynamic analysis of compressor stage, stage loss relationship and efficiency, reaction ratio and choice of reaction, stage loading, stage pressure rise, pressure ratio of a multistage unit, stage
	efficiency, stall and surge phenomena.
	8 hours
	Centrifugal compressors:
	Introduction, kinematic and thermodynamic analysis of compressor stage, inlet casing, impeller, diffuser, conservation of rothalpy, optimum efficiency at inlet of
	pump/compressorship factor, compressor performance, choking in compressor stage. 8 hours
	Introduction to 3-D flow in axial turbomachines.
	3 hours
Text Books,	Text Books:
and/or reference	1. Title: Fluid Mechanics and Thermodynamics of Turbomachinery, Author: Dixon and Hall
material	2. Title: Fluid Mechinery, Author: Wright and Gerhart
	Reference Books:
	 Title: Turbomachinery: Basic Theory and Applications, Author: Earl Logan, Jr Title: Gas Turbine Theory, Author: Saravanamutto, Cohen, and Rogers. 1. Convection

	De	epartment of Mecha	anical Engir	neering			
Course	Title of the course	Program Core	Total Nu	mber of con	tact hours		Credit
Code		(PCR) /	Lecture	Tutorial	Practical	Total	
		Electives	(L)	(T)	(P)	Hours	
		(PEL)					
ME9046	LUBRICATION	PEL	3	0	0	3	3
	ENGINEERING						
Pre-requisit	Pre-requisites		ent methods	s (Continuou	us (CT) and	end assess	ment
		(EA))					
1. Mec	chanics, Solid	CT+EA					
Mec	chanics, Fluid						
Mec	chanics						
Course	CO1: To learn	the basic knowled	lge of surfac	ce topograpl	hy and conta	ct between	1
Outcomes	engineering s	urfaces.	-				
	• CO2: To lear	n the basic theory a	and applicat	ion of fricti	on and wear	for differe	ent
	materials						
	materials						
	CO3: To learn	n about lubricants a	nd lubricati	on for diffe	rent bearings	5	
					8		
	CO4: Introdue	ced to Biotribology	of human j	oints			
			5				
	CO5: Introdu	ced to Microtribolo	gy for MEN	AS applicati	ions		
Topics	Surface topo	graphy: Measure	ment of s	urface topo	ography; Qu	uantifying	surface
Covered	roughness; The	e topography of eng	gineering su	rfaces. (3)			
	-		-				
							Dou

	M. TECH	I. IN FLUID MEC	HANICS AI	ND HEAT '	TRANSFER			
	Contact betwee on cylinder contact betwee o	een surfaces: Her ntact; Contact betw	tzian contac veen rough s	et – sphere surfaces. (5)	on sphere co	ontact and	cylinde	
	• Friction and Friction and W	Wear of contact lear of different material	surfaces: 1 aterials; App	Laws and Tablication to a	Theories of friction mate	friction anrials. (10)	nd wear	
	• Lubricants ar oils and greas Hydrodynamic application to b	nd lubrication: V es; Reynolds equa lubrication; Elasto pearings. (20)	iscosity of ation; Type ohydrodyna	lubricants; of lubricat mic lubricat	Composition ions - Hydre tion; Bounda	and prop ostatic lub ary lubrica	erties orication tion, an	
	• Microtribolog Friction, wear	y: Surface forces and lubrication on	s and adhe atomic leve	sion; Atom l; Applicati	nic force mit ons to MEM	icroscopy S. (8)	(AFM)	
	• Biotribology: Natural human joints; Structure and properties of articular cartil Mechanism of synovial lubrication: Mechanism of articular cartilage damage; Artif joint replacements; Skin Tribology (10)							
Text Books	, Text Books:							
and/or	1) Engineerin	ng Tribology - Dr.	Prasanta Sał	100				
material	2) Introduction	on to Tribology of	Bearings 1	B.C.Majum	der			
	3) Principles	of Tribology I H	alling					
	5) Theples	01 1110010gy J .11	annig					
	4) Basic Lubr	rication Theory - A	Alastair Can	neron				
	De	partment of Mech	anical Engir	neering				
Course	Title of the course	Program Core	Total Nu	mber of con	tact hours	T - (- 1	Credi	
Code		(PCR) / Electives (PEL)	(L)	(T)	Practical (P)	Hours		
ME9047	Multi-Phase Flow and Heat Transfer	PEL	3	0	0	3	3	
Pre-requisit	Pre-requisites (Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA						
Course Outcomes	• Leads students multi phase flo	toward a clear un w and heat transfe	nderstanding r.	g and firm g	grasp of the	basic prin	ciples o	
	• Understands th	e fluid-dynamic in	volved in co	onvection a	nd multi-pha	se heat tra	nsfer.	

- Performs elementary analysis of most gas-liquid two-phase systems and prepares to use more advanced models.
 - Equips the student with the analytical model to apply the fundamentals to a wide variety of complex engineering problems, formulate them and interpret the results.
- Student can analyze Hydrodynamics of three phase flows and compare two phase flow situations.

	One dimensional steady separated flow model (6)
	The time high instance separated flow model, (0)
	Flow in which inertia effects dominate, energy equations, (3)
	The separated flow model for stratified and annular flow, (2)
	General theory of drift flux model, (3)
	Application of drift flux model to bubbly and slug flow, (4)
	Hydrodynamics of solid-liquid and gas-solid flow, (4)
	An introduction to three phase flow, (3)
	Fluid-Population Balance Technique, Volume of Fluid Method, Lattice Boltzmann Model.
	(6)
Text Books,	Ghiaasiaan, S. M., Two-Phase flow, Boiling, and Condensation, Cambridge University
and/or	Press.
reference	Brennen, C.E., Fundamentals of Multiphase Flow, Cambridge University Press
material	Collier, J. G. and Thome, J. R., Convective Boiling and Condensation, 3rd ed., Oxford
	University Press
	Wallis, G.B., One Dimensional Two Phase Flow, McGraw Hill Higher Education.
	Hewitt, G.F., Measurement of Two Phase Flow Parameters.
	Govier, G.W., and Aziz, k., Flow of Complex Mixtures.
	Hetsroni, G., Handbook of Multiphase systems.

Subject	Title of the course	Program	Total N	8	Credit		
Code		Core (PCR)	Lecture	Tutorial	Practical	Total Hours	
		(PEL)	(L)	(T)	(P) [#]		
ME 9048	Advanced	PEL	3	0	0	3	3
	Computation						
	al Fluid						
	Dynamics						

Discretization procedure in finite volume method for diffusion problems: Finite volume method for 1-D steady state diffusion, 2-D and 3-D steady state diffusion, Example problems. Finite volume method for convection-diffusion problems: Steady 1-D and 2-Dconvection-diffusion, Conservativeness, Boundedness and Transportiveness, Central, Upwind, Hybrid and Power law schemes, QUICK and TVD schemes [10]

Pressure - velocity coupling in steady flows: Staggered grid, SIMPLE algorithm, Assembly of a complete method, SIMPLER, SIMPLEC and PISO algorithms [8]

Finite volume method for unsteady flows: 1-D unsteady heat conduction, explicit, Crank-Nicolson and fully implicit schemes, Transient problems with QUICK, SIMPLE schemes. Implementation of boundary conditions: Inlet, Outlet, and Wall boundary conditions, Pressure boundary condition, Cyclic or Symmetric boundarycondition. [8]

Computation of turbulent fluid flow and heat transfer, eddy-viscosity based turbulence modelling : k- ε and k- ω modelling, Conjugate heattransferproblem [10]

Errors and uncertainty in CFD modeling: Errors and uncertainty in CFD, Numerical errors, Input uncertainty, Physical model uncertainty, Verification and validation, Guide lines for best practices in CFD, Reporting and documentation of CFD results. [4]

Text Books:

1. Title: A First Course in Turbulence Author: Tennekes, H. and Lumley, J.

2. Title: Turbulent Flows Author: Pope, S. B.

ReferenceBooks

1. Title: Turbulence: An Introduction for Scientists and Engineers, Author: P.A.Davidson

2. Turbulent Flows, Authors: Biswas, G. and Easwaran, V.

Subject	Title of the course	Program	Total Nu	mber of con			
Code		Core (PCR)	Lecture	Tutorial	Practical	Total	Credit
		/ Electives	(L)	(T)	(P) [#]	Hours	
		(PEL)					
ME 9049	Turbulence and	PEL	3	0	0	3	3
	Turbulent Flows						

Origin, examples & character of turbulence, Reynolds stress, energy relations, closure problem, phenomenology, eddy viscosity. Statistics. Spectra, space-time correlations, macro & micro scales, stat. theory of turbulence, locally isotropic turbulence, Kolmogorov's hypothesis, correlation method, spectral method, turbulent diffusion.Experimentaltechniques. [20]

Types of turbulent flows. Uniform turbulent flows under axial press gradient. Incompressible free turbulent flows: 2-D and axi-symmetric jets; wakes; free shear layer, self-propelled wake, and thermal plume.

Incompressible wall turbulent flows: pipe, channel flow, equilibrium turbulent & compressible BL, wall jet, turbulent transport in homogeneous & shear flow, compressible flows, Turbulence modelling. [20].

Text Books:

1. Title: A First Course in Turbulence Author: Tennekes, H. and Lumley, J.

2. Title: Turbulent Flows Author: Pope, S. B.

ReferenceBooks

1. Title: Turbulence: An Introduction for Scientists and Engineers, Author: P.A.Davidson

2. Turbulent Flows, Authors: Biswas, G. and Easwaran, V.

	Department of Mechanical Engineering									
Course	Ti	tle of the course	Program Core	Total Nu	mber of cor	tact hours		Credit		
Code			(PCR)/	Lecture	Tutorial	Practical	Total			
			Electives (PEL)	(L)	(T)	(P) [#]	Hours			
ME9050	In	troduction to	PEL	3	0	0	3	3		
	Ae	erodynamics								
Pre-requisites		Course Assessment methods: Continuous evaluation (CE), Mid Term								
			Exam(MTE) and I	End Assess	ment (EA)					
Engineering Mechanics, Fluid		CE(15)+MTE (25))+EA(60)							
Mechanics										
Course	Course • CO1: To <u>understand</u> the base				ion equatio	ns				
Outcomes • CO2: To			apply the concept to	aerodynam	nical analys	is				
• CO3: <u>To analyse</u> the flow f				eld around t	he airplane	during it's m	notion			
C	01	1 Equations of Fluid Motion - Navier - Stokes Equation, Conservation of Energy and					l Energy			
		Equation, Equation	ons of Motions, Exa	ct Solution	for Simple	Problems6				
		Aircraft and Aero	dynamic Forces and	nd Moments, Fluids and Forces in Fluids, Kinematics of						
CC)2	fluid motion - V	/elocity with specified extension and vorticity, Vorticity Distribution,							
		Velocity without	t expansion and v	orticity, Ir	rotational	Solenoidal I	Flow in	Multiply		
		Connected region			10					
		Vortex motion :	Helmholtz laws and	d Kelvin's	theorem, P	oint vortex,	vortexshe	et, Biot-		
		Savart law. Inco	mpressible flow page	st airfoils.	Airfoil nor	nenclature a	nd charac	teristics.		
		Kutta condition,	starting vortex.	Method of	singularit	ies and thi	n airfoil	theory.		
		12		~	0 T		- ·	1		
		High Reynolds N	umber Approximation	on, Conditio	ons for Inco	mpressibility	y, Potentia	I Flow -		
		Combination of E	Sasic Solutions – Lif	ting Cylind	er, Conforn	hal Transform	nation, Zh	ukovsky		
		Transformation, 2	Zhukovsky Transfor	mation $-A$	Applications	s, Transform	ation, Bo	undary -		
		Layer Theory	ا	U	1 (D 1/12 1	· · · · · ·	.1		
Incompressible flow past finite wings.				gs. Wing no	omenclature	e. Prandtl's l	itting line	e theory.		

CO3	Induced drag. Effect of geometrical parameter on lift and induced drag. Element of lifting surface theory. Flow past swept and delta wings. Elements of flow past bodies in incompressible flow. Lift, drag and moment characteristics of the entire airplane. 14
Text Books, and/or	 <u>Suggested Text Books:</u> 1) Fundamentals of Aerodynamics by John D. Anderson JR.
reference material	 Suggested Reference Books: 1) Introduction to Theoretical Aerodynamics and Hydrodynamics By William R. Sears

		Department of Mech	nanicalEngi	neering						
Course	Title of the	Program Core	Total Nu	mber of con	Credit					
Code	course	(PCR) /	Lecture	Tutoria l	Practical	Total				
		Electives (PEL)	(L)	(T)	(P)	Hours				
ME 9051	Microsystem	PEL	3		0	3	3			
	Design									
Pre-requisite	es	Course Assessmen (EA))	Course Assessment methods (Continuous (CT) and end assessment (EA))							
Solid Mecha	nics, Fluid	CT+EA								
Mechanics,	Machine Design									
Course	CO1: Able to	understand scope and	application	of Microsy	stems					
Outcomes	CO2: Able to	learn science behind 1	micro syster	n design.						
	CO3: Students	s will be able to analy	ze micro sys	stem by con	nputer aided	tools				
	CO4: Able to	understand the differe	ent manufac	turing techn	ologies for 1	nicro syst	em.			
Topics							Hours			
Covered	Introduction:	Overview of Microsy	stems and N	IEMS, Scal	ing laws in		2			
	miniaturization	, Application of micro	o systems		U					
		• • • • • • • •			111 D'					
	Working Prin	Working Principles of Microsystems: Microsensors like Piezoresistive								
	pressure senso	pressure sensors, micro-accelerometer, optical sensors etc., microactuators,								
	micro pumps, n	nicro valves, micro ge	ears etc.							
	Engineering S	cience for Microsyst	em Design a	and Manuf	acturing: So	caling	4			
	effect in geome	try, molecular theory	of matter ar	nd intermole	ecular forces					
	Flectrokinetic	s•Flectrohydrodynam	ics fundam	entals Flee	tro_osmosis	Debve	4			
	laver Thin El	DL limit Ideal elec	tro-osmotic	flow Ide	al EOF wi	th back	т			
	pressure Casca	pressure. Cascade electro-osmotic micropump. EOF of power-law fluids								
	Electrophoresis	Electrophoresis of particles, Electrophoretic mobility. Electrophoretic velocity								
	dependence on	dependence on particle size.								
	Dielectrophore	Dielectrophoresis, Induced polarization and DEP. Point dipole in a dielectric								
	fluid, DEP forc	fluid, DEP force on a dielectric sphere, DEP particle trapping. AC DEP force on								
	a dielectric sph	a dielectric sphere. Electro-capillary effects, Continuous electro-wetting, Direct								
	electro-wetting	electro-wetting, Electro-wetting on dielectric.								
	Thermo-fluid	Analysis for Micros	ystem Desi	gn: Scaling	g effect in flu	uid flow	4			
	and heat transfe	er, fluid flow in subm	icrometer so	cale, microf	luidics syste	ms, heat				
	conduction in s	olids in submicron lev	vel.							
	Modeling of	Modeling of Coupled Electromechanical Systems: Scaling effect in								
	electrostatic an	d electromagnetic for	ces, coupled	d electrome	chanics of st	tatic and				
	dynamic micros	systems	· 1							
	Matarial for M	liorosystems and M	FMS				2			
	Modern Com	utational Tools for N	Microsyster	ns Design s	and Analysi	s:	<u> </u>			
							- Page			

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	M. TECH. IN FLUID MECHANICS AND HEAT TRANSFER	
,		
	Microsystem Fabrication Technologies: Thin film deposition, Lithography, etching, LIGA, silicon micromachining, inkjet printing etc.	6
	Microsystem Packaging:	2
Text Books,	Text Books:	
and/or reference	Text Books:	
material	1. Microsystem Design by Stephen DSenturia	
	2. Micro and Smart Systems, by Ananthasuresh, Vinoy, Gopalakrishnan, Bhat, Aatr	e
	3. MEMS and Microsystems Design & Manufacture, by Tai RanHsu	
	Introduction to Micromechanisms and microactuators, by A.Ghosh, B.Corve	es
	Reference Books:	
	1. An Introduction to MEMS Engineering, by Nadim and Williams	
	Foundation of MEMS, by ChangLiu	

	Department of Mechanical Engineering							
Course	Title of the	Program Core	Total Nu	mber of cor	tact hours		Credit	
Code	course	(PCR) /	Lecture	Tutorial	Practical	Total		
		Electives (PEL)	(L)	(T)	(P)#	Hours		
ME9052	Gas Turbines	PEL	3	0	0	3	3	
	and Jet							
	Propulsion							
MEC303 (Fluid Mechanics) and		Course Assessmen	nt methods (Mid Term				
MEC304 (Thermodynamics)		Examination(MTI	E),Continuo	us evaluatio	on (CE) and	end assess	ment	
		(EA))						
NIL		MTE(25)+CE(15)	+EA(60)					
Course								
Outcomes	CO1. <u>To recall</u>	the fundamentals of	Gas Turbin	les and ther	modynamics	of jet pro	pulsion	
Outcomes	CO2: <u>To analys</u>	$\underline{\mathbf{e}}$ the performances of \mathbf{e}	of Axial flo	w and cent	rifugal flow	GasTurbin	es	
	CO3: <u>To Predic</u>	the Performances	ofAir Breath	n ng and No	on Air Breath	iing Engin	es	
	(Solid Ro	cket Motors and Liq	uid Kocket	Engines).				
	Part-I: Gas Turl	bine:						
CO1	Deview of De	ais themes dragonic	a and asm	maggible f	owa Eulor'	Turkom	achinemy	
	Equations	isic thermodynamic	s and com	pressible II	ows. Euler		achinery	
Equations. 4					c. Store			
CO2	Derivation of avi	Euler Turbine equi	autoit tot be	uli axial a	nu cenunug	al turbine	s. Stage	
	flow cos turbin		i and withou	it swift. Pai	ametric anal		ntrifugai	
	Dowt II. IET DD	ODUI SION				10		
	<u>Fart-II: JET FK</u>	<u>OPULSION</u> Enginese Derive	tion of con	analized as	uction / own	acciona fa	a though	
COI	Air Dreathing	rer Ideal Brayton cycle and derivation of thermal efficiency of Ideal						
	Propulsive por	Dropulaiua offician	cycle allu		or unerman e	ficiency	Deletion	
	brayton cycle.	Thermodynamic on	by, inclinat	enticlency a	ulu Overall e	angings.	Specific	
	Thrust Fuel	air ratio TSEC('	Thrust spor	pific fuel	consumption	Condi	specific for	
	maximum over	all ficionau	Thrust spec	line luei	consumption	i),. Collai		
	Derformence e	nalucia of the follow	in a.			U		
CO3	(a) Pariot (harysis of the follow	llig. d) Eon ovho	ustad turba	iat & Fan mi	vad turbai	ot	
	(a) Kallijet, ((b) Furbojet (standard), Fan exhausted turbojet & Fan mixed turbojet						
CO	1 Non air breat	hing ongines. Der	formance of	E Dooleot vo	hicles such	us og Thruct	nocific	
	Impulse (L.)	which accoloration	and burning	time	sincies such	as must,	specific	
CO3	Type of shere:	col Dockota, Colid D	and Durning	s unit.	id Dockat Er	$\frac{2}{1}$	montom	
	theory and por	tai NUCKEIS: SUIIA K	utics of both	types of ch	emical rocket	igilies. Ele	A	
				types of ch			+	
Text Books.	Text Books:	1.1 1 .	c	D C V	11.0.05.5			
and/or	1. Mechanics a	nd thermodynamics	of propulsio	on: P. G. Hi	ll & C.R. Pe	terson.		
reference	2. Elements of	Gas Turbine Propuls	sion- Jack I	D. Mattingly	у.			
material	Reference Book	KS:						
	1. Aircraft Propulsion : V. Babu							

Department of Mechanical Engineering									
Course	Title of the	Program Core	Total Nu	mber of con	tact hours		Credit		
Code	course	(PCR) /	Lecture	Tutorial	Practical	Total			
		Electives (PEL)	(L)	(T)	(P) [#]	Hours			
ME9053	Theory of	PEL	3	0	0	3	3		
	Combustion								
MEC303 (Flu	uid Mechanics) and	Course Assessmen	nt methods (Mid Term					
MEC304 (Th	ermodynamics)	Examination(MTH (EA))	E),Continuo	us evaluatio	on (CE) and e	end assess	ment		
NIL MTE(25)+CE(15)+EA(60)									
Course Outcomes	CO1. <u>To recall</u> combustic CO2: <u>To analys</u> explosion CO3: <u>To Predic</u>	 CO1. <u>To recall</u> the fundamentals of fluid mechanics and thermodynamics related to combustion of solid and liquid propellant. CO2: <u>To analyse</u> the Flames theories for premixed and diffusion flame and theories of explosion and detonation. CO3: <u>To Predict</u> the combustion stability and combustion instabilities. 							
CO1	Review of Basic reaction kinetic	fluid mechanics and s.	d thermody	namics rela	ited to comb	ustion. Re 1(eview of		
CO2	Flame theories fo	r premixed and diffu	sion flames	. Explosion	theories and	Detonatio	on		
	theory.					12	2		
CO3	Flame stabilization	on and combustion in	stabilities.	Solid and li	quid propella	int combus	stion.		
	Erosive burning of	of solid propellant gr	ains. Deflag	gration to de	etonation tran	nsition. 14	Ļ		
Text Books, and/or reference material	Text Books: 1. An introduce Reference Book 2. Combustion	ction to combustion ss: a Engineering by Bo	b y Stephe forman and F	n R. Turn Ragland					

Department of Mechanical Engineering								
Course	Title of the course	Program	Total Nu	mber of cont	act hours		Credit	
Code		Core (PCR)	Lecture	Tutorial	Practical	Total		
		/ Electives	(L)	(T)	(P) [#]	Hours		
		(PEL)						
ME9054	Renewable Energy	PEL	3	0	0	3	3	
	Sources							
	Topics Covered						Hours	
	Energy scenario and	renewable en	ergy sourc	es: global a	and Indian s	situation.	15	
	Potential of non-conventional energy sources, economics. Solar Radiation: Solar							
	thermal process, heat	transfer devices	s, solar radi	ation measu	rement, estin	nation of		
	average solar radiation	n. Solar energy s	storage: stra	tified storage	e, well mixed	storage,		
	comparison.							
	Hot water system, pra	ctical consideration	tion, solar p	onds, Non-c	onvective sol	lar pond,	15	
	extraction of thermal	energy and ap	plication of	f solar pond	s. Wind ener	rgy: The		
	nature of wind. Wind	energy resource	es and mod	elling. Geoth	ermal energy	y: Origin		
	and types of geothermal energy and utilization.							
	OTEC: Ocean temperature differences. OTEC systems. Recent OTEC						10	
	developments. Wave energy: Fundamentals. Availability Wave-energy conversion							
	systems. Tidal energy: Fundamentals. Availability Tidal-energy conversion							
	systems. ; Energy from	m biomass: Pho	tosynthesis	; Biomass re	source; Utili	sation of		
	biomass.							

Text	Text Books:
Books,	1. Solar Energy Principle of Thermal Collection and Storage', S.P. Sukhatme TMG,
and/or	2. N.K.Bansal, Renewable Energy Source and Conversion Technology', TMG, 1989.
reference	Reference Books
material	1. G.L. Johnson, Wind energy systems, Prentice Hall Inc. New Jersey.
	2.Non-conventional Energy Sources D. S. Chauhan and S. K. Srivastava

Department of Mechanical Engineering									
Course	Title of the course	Program	Total Nu	mber of cont	act hours		Credit		
Code		Core (PCR)	Lecture	Tutorial	Practical	Total	1		
		/ Electives	(L)	(T)	(P) [#]	Hours	1		
		(PEL)							
ME9055	Power Plant	PEL	3	0	0	3	3		
	Engineering								
	1 opics Covered								
	Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants.								
	Hydro Electric Powe	r Plants: Rainfa	ll and run-	off measure	ments and pl	otting of	4		
	various curves for e	stimating stream	n flow and	l size of res	servoir, powe	er plants	-		
	design, construction a	nd operation of	different co	omponents of	hydro-electr	ic power	l		
	plants, site selection,	comparison with	other types	s of power pl	ants.		L		
	Steam Power Plants:	Flow sheet an	d working	of modern-t	hermal powe	er plants,	10		
	super critical pressure	e steam stations,	site selecti	on, coal stor	age, preparat	ion, coal	l		
	handling systems, fee	eding and burning	ng of pulve	rized fuel, a	ish handling	systems,	l		
	dust collection-mecha	inical dust collec	tor and elec	ctrostatic pre	cipitator.				
	Steam generators ar	nd their access	ories: Hig	n pressure	Boilers, Acc	essories,	4		
	Fluidized bed boller.		~ ~ ~	<u> </u>					
	Condensers: Direct	Contact Conden	ser, Surfac	e Condense	rs, Effect of	various	5		
	cooling ponds	iser performance	e, Design o	1 condensers	s, Cooling to	wers and	1		
	Combined Cycles: C	onstant pressure	gas turbin	e power pla	nts, Arrange	ments of	5		
	combined plants (stea	m& gas turbine	power plan	nts), re-powe	ring systems	with gas	l		
	production from coa	al, using PFBC	systems,	with organi	ic fluids, pa	rameters	l		
	affecting thermodynamic	mic efficiency of	f combined	cycles.					
	Nuclear Power Plan	ts: Principles of	of nuclear	energy, bas	ic nuclear r	eactions,	5		
	nuclear reactors, BWI	R, CANDU, Sod	ium graphi	te, fast breed	er, homogene	eous; gas	l		
	cooled. Advantages a	nd limitations, n	uclear powe	er station, wa	iste disposal.				
	Power Plant Econor	nics: load curv	e, differen	t terms and	definitions,	cost of	5		
	electrical energy, tar	iffs methods of	electrical	energy, perf	ormance & c	operating	l		
	characteristics of po	wer plants- ind	cremental 1	theory,	input-output	curves,	l		
Text	Text Books	conomic toad si	iaiiig, Prot	DUTIIS.					
Books	$\frac{1}{1} Na\sigma P K Pox$	ver Plant Engine	ering 2nd	Tata McGrav	v-Hill 2011				
and/or	2 Power plant T	echnology by 'N	I M Fl_Wal	zil' McGrou	r Hill Com	985			
reference	2. Tower plain T	connotogy by Iv	1.1v1.151- vV al			1905.			
material	1 Black Veatch	Power Plant Fr	gineering	CBS 2005					
	2 Power plant or	gineering by 'A	rrora&Don	hundwar' T)hannatRai <i>k</i> r	Sons Ner	v Delhi		
	2. 10wei plait ei 2008	ignicering by A		ikunuwai , L	manpantaix	50115, 1101	v Denn,		
	2008								

Department of Mechanical Engineering							
Course	Title of the course	Program Core	Total Nu	mber of cor	ntact hours		Credit
Code		(PCR) /	Lecture	Tutorial	Practical	Total	
		Electives (PEL)	(L)	(T)	(P)	Hours	
ME90**	HEAT AND FLUID	PEL	3	0	0	3	3
	FLOW IN POROUS						
	MEDIA					<u> </u>	
Pre-requisi	ites	Course Assessmer	nt methods ((Continuou	s (CT) and er	nd assessm	nent
		(EA))					
MEC 303	(Fluid Mechanics),	CT+EA					
MEC 304	(Engineering						
Thermody	namics) and MEC						
403 (Heat	and Mass Transfer)		(C 1	11' C	1.		
Course	• COI: To lea	rn fundamental conc	ept of mode	elling of a p	orous mediu	m 1.	
Outcomes	• CO2: To lea	rn the fundamental c	concept of h	eat conduct	10n in porous	s medium	
	• $CO3$: To lea	rn the fundamental c	concept of fi	uid flow in	porous medi	um tions in m	
	• CO4: 10 lea	rn the fundamental c	concept of Id	breed and n	atural convec	ctions in p	orous
		rn tha fundamental a	oncont of r	diativa haa	t transfor in	norous mo	dium
	• $CO5$. To lea	n ne rundamentar c	nodolling of	ulative liea	ological syst	porous me	ululli
Topics	• CO0. 10 app	lamontal concent:			ological syst		
Covered	Definition n	prosity permeability	· canillary r	nodels hvd	raulic radius	model dr	au
Covered	model for per	model for pariodic structure: parcelation and tortuosity, volume averaging DEV [6]					
	II Conduction in norous medium:						
	First law of t	hermodynamics loca	al thermal e	milibrium	porous medi	um enerov	7
	equation: sec	ond law of thermody	namics: eff	ective therr	nal conductiv	vity. therm	nal
	dispersion: th	ermal non equilibriu	im model (I	TNE): tran	sient heat co	nduction i	n
	porous media	ı [8]					
	III. Fluid	l flow through pord	ous medium	ı:			[-]
	Stokes flow a	and Darcy equation, Hazen-Dupuit-Darcy (HDD) model; high Reynolds					
	number flows	s, macroscopic mode	els, microsco	opic fluid d	ynamics; Bri	nkman mo	odel;
	semi-heuristi	c momentum equation	ons.				[10]
	IV. Forc	ed convection throu	igh porous	medium:			
	Energy equa	tion; forced convecti	ion in porou	s medium o	over a flat pla	ate; forced	
	convection in	porous channel.					[6]
	V. Natu	ral convection thro	ough porous	s medium:			
	Natural conv	ection boundary laye	ers—vertica	l and horizo	ontal walls, n	atural con	vection
	with thermal	gradient; non-Darcy	, LTNE and	heat gener	ation effects.		[6]
	VI. Radi	ation in porous me	dium:				503
	Radiative trai	nster equation (RTE)), energy eq	uation with	radiation.		[3]
	VII. Mass	s transfer in porous	medium:			1.1	
	Fick diffusion	n; local volume-aver	aged mass c	conservation	n equation; n	nulticompo	onent
Trank Darala	flow; mass co	onservation in a mixt	ure.				[3]
1 ext Book	s, I ext Books:	Ugat Transfor in Da	roug Madia	by M Va-	tions Comina	or Now V	ork
anu/or	1. Principies of (1000)	ricat fransfer in Po	nous meula	, uy ivi. K av	rany, spring	ci, inew i	UIK
material	(1999). 2 Fecantial of	Heat and Fluid Flow	through Po	rous Madie	hy Arunn N	Jarasimho	n Anno
material	2. Essential Of Rooks Now	Delhi 2013	unough PC		i, by Aruini r	varasiiiiilä	n, Anne
	3 Convection	in Porous Media by	Nield Don	ald A Rain	n Adrian S	nringer 7	013
	4 Modeling D	nenomena of Flow at	nd Transnor	t in Porous	m, Auran, S Media, by Ia	pringer, 20	515.
	Springer 20	18	ia manspor	t III I OLUUS	meula, Uy Je	COU Deal,	
	Springer, 20	10.					
