Course Code	**BSC_ME501**				
Category	**Basic Science Course**				
Course Title	**Complex Analysis**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	2	**1**	**0**	**3**	
Pre requisites	**Set theory, Calculus of real functions, Algebra of complex numbers.**				

Objectives:

To study the techniques of complex variables and functions together with their derivatives. and classification of singularities, calculus of residues and its applications in the evaluation of integrals, and other concepts and properties.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Analytic functions- function of a complex variable, limit, continuity and differentiability of complex function, analytics functions, harmonic functions, necessary and sufficient conditions for a complex function to be analytic, polar form of cauchy riemann equations, construction of analytic function whose real and imaginary part is given.	10
Module 2.	Complex integration- definite Integrals of functions w(t), *ML* theorem, Cauchy's fundamental theorem, Cauchy's integral formula, Cauchy's integral formula for derivatives, Cauchy's inequality, Liouville's theorem, Morera's theorem.	9
Module 3.	Taylor and Laurent series- Taylor's and Laurent's Expansion, classifications of singularities, removable singularity, zeros of a function, poles and behaviour of a function at a pole , essential singularity.	9
Module 4.	Residue theorem and applications- residues, residue at a pole, residue at infinity, Cauchy's residue theorem, residues at finite pole, evaluation of integrals by the method of residues (contour integration).	9
Module 5.	Mobius transformation, properties and classification, fixed point and cross ratio.	5
Total number of Hours		**42**

Course Outcomes:

At the end of the course:

Demonstrate understanding of the basic concepts underlying complex analysis and their role in modern mathematics and applied contexts **(L3)**.

Demonstrate familiarity with a range of examples of these concepts **(L3)**.

Apply the methods of complex analysis to evaluate definite integrals and infinite series **(L3).**

Apply problem-solving using complex analysis techniques to diverse situations in physics, engineering and other mathematical contexts **(L3)**.

S.No:	**Text Books**	**Author**	**Publisher**
1.	Complex Variables and Application	James Ward Brown and Ruel Churchill	McGraw-Hill International Book Company.
	References		
1.	Advanced Engineering Mathematics	R.K. Jain & S.R.K. Iyengar	Narosa Publishing House
2.	Theory of Functions of Complex Variables	E.T. Copson	Oxford University Press
3.	Foundation of Complex Analysis	S. Ponnusamy	Narosa Publishing House

Course Code	**PCC_ME502**				
Course Category	**Professional Core Course**				
Course Title	**Heat Transfer**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	3	**1**	**0**	**4**	
Pre requisites	**Basic Thermodynamics, Fluid Mechanics**				

Objectives:

To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries

M. No:	**Topic**	**No. of Hrs**
Module 1.	Conduction heat transfer, one-dimensional steady and unsteady state problems, fins, multidimensional problems.	15
Module 2.	Convection mode of heat transfer, external flows, boundary layer flow on a heated flat plate, thermally and hydro-dynamically fully developed flow through a pipe, turbulent flow, Dittus Boelter's and Sieder-Tate correlation.	12
Module 3.	Natural convection, non-dimensional numbers, natural convection over surfaces, natural convection from finned surfaces and *PCB*s	7
Module 4.	Heat exchangers and their types, the overall heat transfer coefficient, analysis of heat exchangers, the LMDT, counter-flow heat exchangers, multi-pass and cross-flow heat exchangers, the effectiveness-*NTU* method, selection of heat exchangers.	09
Module 5.	Radiation- fundamental concepts, black body radiation, surface emission, surface properties, Kirchoff's law, view factor, black body radiation exchange.	09
	Total number of Hours	**52**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the basic modes of heat transfer **(L2).**
- ***Compute*** one dimensional steady state heat transfer with and without heat generation
- ***Understand*** and analyze heat transfer through extended surfaces**(L2, L4).**
- ***Understand*** one dimensional transient conduction heat transfer **(L2).**
- ***Interpret*** and analyze forced and free convective heat transfer **(L5)**.
- ***Understand*** the principles of radiation heat transfer **(L2)**.
- ***Design*** of heat exchangers using LMTD and NTU methods **(L6).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Heat & Mass Transfer	by P.K. Nag,	McGraw Hill
2.	Heat Transfer.	S P Sukhatme.	Orient Longman Ltd.
	References		
1.	Heat and Mass Transfer: Fundamentals and Application	Yunus Cengel,	McGraw Hill
2.	Fundamental of Heat and Mass Transfer	Incropera and Dewitt,	Wiley Publication
3.	Heat Transfer	Mills and Ganesan	Pearson Education
4.	Heat Transfer	J P Holman	McGraw Hill

Course Code	**PCC_ME502L**				
Category	**Professional Core Course**				
Course Title	**Heat Transfer Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	0	**0**	**2**	**1**	

Objectives:

To understand experimentally, the modes of heat transfer mechanisms viz conduction based using composite wall apparatus, heat transfer coefficients in case of Convection (forced and natural types) and Heat exchangers, emissive power calculations of gray bodies.

M. No:	**Topic**
Module 1.	To determine the thermal conductivity of given metal rod.
Module 2.	To determine the thermal conductivity of the given composite wall.
Module 3.	To determine the thermal conductivity insulating powder.
Module 4.	Heat pipe demonstration (superconductivity of material).
Module 5.	To determine Stefan Boltzmann constant experimentally.
Module 6.	To determine heat transfer coefficient by forced convection.
Module 7.	To determine heat transfer coefficient by natural convection.
Module 8.	To determine the overall heat transfer coefficient of shell and tube type heat exchangers.
Module 9.	To determine the emissivity of a gray body.
Module 10.	To study drop & film wise condensation & determine the film coefficient.
Module 11.	To measure convective heat transfer co-efficient and effectiveness of the fin under forced convection.
Module 12.	To measure convective heat transfer co-efficient and effectiveness of the fin under natural convection.

Course Code	**PCC_ME503**				
Category	**Professional Core Course**				
Course Title	**Fluid Machinery**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	2	**1**	**0**	**3**	
Pre requisites	**Fluid Mechanics, Dynamics**				

Objectives:

To introduce application of conservation of angular in turbomachines, the basic theory of hydraulic machines, design principles of turbines and pumps and to use them in engineering applications..

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to fluid machinery, classification of fluid machines, energy transfer in turbomachines, application of dimensional analysis and model testing for turbomachines, dimensionless groups and specific speed.	10
Module 2.	Hydraulic turbines, classification of turbines, efficiencies of turbine, impulse turbines (pelton turbine), components of pelton turbine, analysis of Pelton wheel.	06

Module 3.	Radial-flow turbines—Francis turbines, analysis of Francis runner, axial-flow turbines—Propeller and Kaplan turbines, analysis of Kaplan/ Propeller runner, turbine characteristics, inlet and outlet elements of the turbine.	06
Module 4.	Heads of pump installation, energy gradient line of pumping system, centrifugal pump impeller and velocity triangles, axial flow or propeller pump, velocity triangle and analysis, pump and system characteristics, pumps in series and parallel, inlet and outlet elements of pumps.	06
Module 5.	Head losses in components of turbine and pump systems, pipes, cavitation in turbines and pumps, water hammer.	05
Module 6.	Introduction to reciprocating pumps, acceleration head, air vessels, double acting pumps, multi cylinder pumps.	04
Module 7.	Hydraulic systems, hydraulic accumulator, hydraulic lift and hydraulic press, fluid coupling and torque converter, hydraulic ram.	03
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** different types of turbomachines **(L2).**
- ***Develop*** the Euler equation for turbomachine and connect the same to transport theorem **(L6).**
- ***Describe*** the method of drawing velocity triangles and calculate energy transfer and degree of reaction in turbomachines **(L1).**
- ***Application*** of free and forced vortex flows in turbomachinery **(L3)**.
- ***Apply*** Buckingham pi theorem and ***express*** the efficiency of pump and turbine in terms of various relevant dimensionless numbers **(L3, L2).**
- ***Understand*** the principle of operation and nature of energy transfer in hydraulic turbines **(L2).**
- ***Study*** the performance characteristics of hydraulic turbines **(L1).**
- ***Explain*** the principle of operation and advantages of centrifugal and axial pumps **(L5).**
- ***Discuss*** the performance characteristics of centrifugal and axial pumps **(L2)**.
- ***Summarize*** the necessities and limitations of pumps in series and in parallel **(L5).**
- ***Explain*** the inception of cavitation, probable damages and methods to avoid it **(L5).**
- ***Describe*** the concepts of net positive suction head, Thoma's cavitation parameter **(L1).**
- ***Understand*** the basic principles of operation and nature of energy transfer in positive displacement machines **(L2).**

M. No:	**Text Books Recommended**	**Author**	**Publisher**
1.	Turbomachinery	Maneesh Dubey BVSSS Prasad Archana Nema	McGraw Hill Education
	References		
1.	Principles of Turbomachinery	R.K Turton	Chapman and Hall
2.	Turbomachinery Design and Theory	Rama S. R. Gorla, Aijaz A. Khan	Marcel Dekkeirnc
3.	Hydraulic Machines: Turbines and Pumps	Grigori Krivchenko	Lewis Publishers

Course Code	**PCC_ME503L**				
Category	**Professional Core Course**				
Course Title	**Fluid Machinery Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	0	**0**	**2**	**1**	
Pre requisites					

S.No:	**Topic**
Module 1.	Impact of jet of water on vane (To find the coefficient of impact of jet on flat circular and hemispherical vanes).
Module 2.	Study of Pelton turbine (To conduct performance test on the Pelton turbine).
Module 3.	Study of Francis turbine (To conduct performance test on the Francis turbine).
Module 4.	Study of Kaplan turbine (To conduct performance test on the Kaplan turbine).
Module 5.	Study of centrifugal Pump (To analyse the pump and system characteristics).

Course Code	**PCC_ME504**				
Category	**Professional Core Course**				
Course Title	**Theory of Machines-II**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	2	**1**	**0**	**3**	
Pre requisites	**Statics, Dynamics and Solid Mechanics.**				

Objectives:

To learn how to treat the vibration phenomena by transforming the physical model into a mathematical model and solve it by using the appropriate mathematical operations.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Importance of the study of vibration, terminology for vibration analysis basic concepts of vibration, classification of vibration, procedure of vibration analysis, spring elements, mass or inertia elements, damping elements, types of damping, harmonic motion, phenomena of beats, non harmonic motions, harmonic analysis.	06
Module 2.	Modeling of *SDOF* systems, free vibration of *SDOF* systems, equilibrium and energy methods for determining natural frequency, Rayleigh's methods, D'Alembert's principle, equivalent systems, systems with compound springs, standard Form of differential equation governing SDOF systems, free vibrations of an damped system (underdamped, critically damped, over damped).	10
Module 3.	Forced vibration of undamped *SDOF* systems, forced response of a viscously damped *SDOF* system, response due to harmonic excitation of support, transmissibility, vibration isolation and commercial isolators, principles of vibration measuring instruments, power consumption in vibrating system.	10
Module 4.	Free undamped vibration of two degrees of freedom systems, natural frequencies and mode Shapes, static and dynamic coupling, un-damped dynamic vibration absorber, friction damper, approximate solution of vibration problems of light flexible shafts with and without damping, vibrations of continuous systems.	05

Module 5.	Force analysis of mechanisms, dynamic force analysis, equivalent dynamic system, dynamic analysis of reciprocating engines.	06
Module 6.	Balancing of four-bar linkage and slider crank mechanism balancing of radial, in line, V-and locomotive engines.	05
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Analyse*** the vibration phenomena as a mathematical model and solve it to obtain the response **(L4).**
- ***Understood*** the parameters and variables of a vibrating system **(L2).**
- ***Analyze*** the mathematical modeling of the two degrees of freedom systems **(L4)**.
- ***Determine*** the natural frequency of transverse vibrations of the shaft and torsional vibrations of rotor systems **(L5).**
- ***Explain*** the modal analysis of a vibrating system **(L5)**.
- ***Determine*** natural frequencies of the beam and rotor systems **(L5)**.

S.No:	**Text Books**	**Author**	**Publisher**
1.	Mechanical Vibrations Theory and Applications	S. Graham Kelly	Cengage Learning
	References		
1.	Theory of Vibrations with applications	Thomson. W.T	Pearson Education, 2010
2.	Elements of vibration analysis	Meirovitch	McGraw Hill, 2011
3.	Theory of Vibrations with applications	Thomson. W.T	Pearson Education, 2010

Course Code	**PCC_ME504L**				
Category	**Professional Core Course**				
Course Title	**Theory of Machines-II Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	0	**0**	**2**	**1**	

M. No:	**Topic**
Module 1.	Study time period of different pendulums.
Module 2.	Compare the time periods of rod and thread pendulum.
Module 3.	Verify radius of gyration of a given pendulum.
Module 4.	Study free undamped vibrations of equivalent spring mass systems.
Module 5.	Study forced undamped vibrations of equivalent spring mass system.
Module 6.	Study undamped torsional vibrations of single rotor shaft system.
Module 7.	Study damped torsional vibrations and determine damping coefficient of single rotor shaft system.
Module 8.	Study forced (damped & undamped) vibration of a simply supported beam with damping.
Module 9.	Study and observe the effect of unbalanced reciprocating masses in an engine

Course Code	**PCC_ME505**				
Category	**Professional Core Course**				
Course Title	**Solid Mechanics-II**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 5 (Five)**
	3	**1**	**0**	**4**	
Pre requisites	**Statics**				

Objectives:

Understanding the deflection and analysis of structural members, concept of elastic stability of structural members and the reasons and criteria of failure of machine elements and structural components.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Deflection of beams, differential equations of the deflection curve, deflections of statically determinate and indeterminate beams by integration of the bending-moment equation, method of superposition, moment-area method, Macaulay method or use of singularity function and Castigliano's theorem.	14
Module 2.	Bending of curved bars, bars of small and large initial curvatures, stress in a circular ring, chain link, deflection of curved bars.	14
Module 3.	Columns, buckling and stability, beam column equation, columns with pinned ends, columns with other support conditions, Rankine formula, columns with eccentric axial loads, the secant formula for columns, elastic and inelastic column behavior.	12
Module 4.	Theories of failure, maximum principal stress theory, maximum principal strain theory, maximum shear stress theory, total strain energy theory, distortion energy theory, octahedral stress theory, Mohr's theory.	12
	Total number of Hours	**52**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Analyse*** the structural members and predict the failure **(L4).**
- ***Analyse*** the structural members for its maximum deflection/stress/strain/buckling **(L4).**
- ***Apply*** the failure theories to design structural members or machine elements **(L3).**

S.No:	**Text Books**	**Author**	**Publisher**
	Mechanics of Materials	Beer and Johnston	McGraw Hill, 2015
	References		
	Mechanics of Materials	J.M. Gere and S.P. Timoshenko	Cengage Learning, 1997
	Engineering Mechanics of Solids	Popov. E.P	Prentice Hall of India, 2004
	Mechanics of Materials	Hibbeler R.C	Pearson Education, 2007

Course Code	**OEC_ME506**				
Category	**Open Elective Course**				
Course Title	**Automation in Manufacturing**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 5 (Five)**
	2	**1**	**0**	**3**	
Pre requisites	**Manufacturing Technology**				

Objectives:

the students will get a comprehensive picture of computer based automation of manufacturing operations

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to *CAD, CAM, CIM*, rigid automation, part handling, machine tools. flexible automation, computer control of machine tools and machining centers, *NC* and *NC* part programming, *CNC*-adaptive control, automated material handling, assembly, flexible fixturing, introduction to cellular manufacturing and flexible manufacturing systems.	15
Module 2.	Computer aided design- fundamentals of *CAD*, hardware in *CAD*-computer graphics software and database, geometric modeling for downstream applications and analysis methods- computer aided manufacturing, *CNC* technology, *PLC*, micro-controllers.	10
Module 3.	Low cost automation- mechanical & electro mechanical systems, pneumatics and hydraulics, illustrative examples and case studies.	05
Module 4.	Introduction to modeling and simulation: product design, process route modeling, optimization techniques, case studies & industrial applications, introduction to additive manufacturing.	07
Module 5.	Elements of integration– controllers, sensors, robots, automated machines- *AGVs, AS, RS*, *etc*.	05
Total number of Hours		**42**

Course Outcomes:

At the end of the course, the student will be able to:

- ***Understand*** the importance of automation in the off field machine tool based manufacturing **(L2).**
- ***Remember*** various elements of manufacturing automation – *CAD/CAM*, sensors, pneumatics, hydraulics and CNC **(L1).**
- ***Understand*** the basics of product design and the role of manufacturing automation **(L2).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Automation, Production Systems, and Computer-integrated Manufacturing	Mikell P. Groover,	Prentice Hall
	References		
1.	Manufacturing–Engineering and Technology.	Serope Kalpakjian and Steven R. Schmid,	Pearson/ 7th Edition
2.	Computer control of manufacturing system	Yoram Koren,	
3.	CAD/CAM: Theory & Practice	Ibrahim Zeid ,	

Course Code	**OEC_ME506L**				
Category	**Open Elective Course**				
Course Title	**Automation in Manufacturing Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 5 (Five)**
	0	**0**	**2**	**1**	
Pre requisites	**-**				

Objectives:

The students will get a comprehensive picture of computer based automation of manufacturing operations

M. No:	**Topic**
Module 1.	CNC lathe programming, turning, multipoint turning cycles.
Module 2.	CNC milling programming, pocket milling, pattern repetition.
Module 3.	CAD modelling using Autodesk inventor/ Solid works.
Module 4.	CAM using Solid works/ Inventor.