2018.2.20 **<u>विश्वविद्यालय के आगामी शैक्षणिक सत्र 2018-19 हेतु विभिन्न विभागो द्वारा परास्नातक पाठ्यक्रमों में किये गये संशोधनों (परास्नातक पाठ्यक्रमों में कोई नया विषय आरम्भ किया जाना है, किसी विषय के **Credit Structure** में कोई संशोधन किया जाना है अथवा किसी विषय के पाठ्यक्रम में संशोधन) पर विचार एवं अनुमोदन।</u>**

विश्वविद्यालय के आगामी शैक्षणिक सत्र 2018-19 हेतु विभिन्न विभागो द्वारा परास्नातक पाठ्यक्रमों में किये गये संशोधनों यथा नया विषय आरम्भ किया जाना, किसी विषय के Credit Structure में कोई संशोधन अथवा किसी विषय के पाठ्यक्रम में किये गये संशोधन विद्या परिषद के माननीय सदस्यों के अवलोकनार्थ पृष्ठ संख्या 349 से पृष्ठ संख्या 482 पर प्रस्तुत है:-

विभाग	पाठ्यक्रम	प्रभावी होने का सत्र
जनपदीय अभियंत्रण विभाग	एम0टेक0	2018-19
कम्प्यूटर साइंस एण्ड इंजी0	एम0टेक0	2018-19
	एम0सी0ए0	2018-19
विद्युत अभि0 विभाग	एम0टेक0	2018-19
विद्युतकण एवं संचार अभि0	एम0टेक0	2018-19
यांत्रिक अभियंत्रण	एम0टेक0	2018-19

विद्या परिषद के माननीय सदस्यों से अनुरोध है कि कृपया उक्त का अनुमोदन प्रदान करने की कृपा करें।

MINUTES OF THE MEETING OF DEPARTMENTAL BOARD OF STUDIES (BOS) FOR PG PROGRAMME HELD ON 19-05-2018 IN THE OFFICE OF HEAD, MECHANICAL ENGINEERING DEPARTMENT

The Board of Studies (BoS) meeting was held on 19.5.2018 to review the Postgraduate (PG) course curriculum. The following members were present during the meeting.

1.	Prof. S.C. Jayswal	Prof. & Head	Chairman
2.	Prof. D. K. Singh	Professor	Internal Member
3.	Prof. S. K. Srivastava	Professor	Internal Member
4.	Dr. Jeeoot Singh	Associate Professor	Internal Member
5.	Dr Sanjay Mishra	Associate Professor	Internal Member
6.	Dr Rajesh Kumar Verma	Associate Professor	Internal Member
7.	Sri Devesh Kumar	Assistant Professor	Internal Member
8.	Sri Ram Bilas Prasad	Assistant Professor	Internal Member
9.	Sr. Sunil Kumar Yadav	Assistant Professor	Internal Member
10.	Sri Prashant Saini	Assistant Professor	Internal Member
11.	Dr. Laxmikant Yadav	Assistant Professor	Internal Member
12.	Prof. K. N. Pandey	Professor, MNNIT Allahabad	External Expert
13.	Prof. J.Ramkumar	Professor, I.I.T Kanpur	External Expert
14.	Sri H. R. Jaiswal	Urja BioMass Gasifier, Gorakhpur	Industry Expert

Following members could not attend the meeting.

Sri. Anil Tiwari, Suptd. Engineer, UP Power Corporation, Lucknow
Sri R. N. Mall , Assistant Professor, MMMUT, Gorakhpur.
Dr. Swati Gangwar, Assistant Professor, MMMUT, Gorakhpur
Sri. Dheerendra Singh, Assistant Professor, MMMUT, Gorakhpur

The following decisions were taken:

1. The syllabus of some of the subjects are modified considering current market demands.
2. Some new things are also introduced from R&D purpose.

19/5/18 19.5.2018

3. A new subject "Computational Methods in Engineering" is introduced in I[st] semester which is common for ETM and CIM students.
4. The modified syllabus will be effective for students admitted in I[st] year from session 2018-2019 onwards.

The meeting ended with the vote of thanks to the Chair.

. Laxmikant Yadav | Prashant Saini | S K Yadav | R.B.Prasad

Devesh Kumar | Rajesh Kr Verma 19/5/18 | Sanjay Mishra | Jeeoot Singh

S.K. Srivastava | D. K. Singh 19/05/18 | K. N. Pandey 19.8.2018 | J. Ramkumar 19/5/18

H.R.Jaiswal | S.C. Jayswal

Copy to: Dean Post Graduate studies and R&D for kind information and necessary action.

MECHANICAL ENGINEERING DEPARTMENT
M. M. M. UNIVERSITY OF TECHNOLOGY
GORAKHPUR

Overall Credit Structure for M.Tech. Programme

Credit Courses			
Postgraduate Core (PC)		**Postgraduate Electives (PE)**	
Category	**Min. Credits**	**Category**	**Min. Credits**
Maths (M)	4	Program Electives (PE)	16
Program Core (PC)	22		
Minor Project (MP)	4		
Dissertation (D)	18		
Seminar (S)	2		
	50		**16**
Total		**66 (min.)**	
Audit Courses			
Audit Courses (Other Departments)	**6** (min.)		
Grand Total	**6 (min.)**		

Credit Structure M.Tech. (Computer integrated Manufacturing)

Category **Semesters**	**I**	**II**	**III**	**IV**	**Total**
Maths (M)	5	-	-	-	5
ProgrammeCore (PC)	13	9	-	-	22
Program Electives (PE)	-	8	8	-	16
Minor Project (MP)	-	-	4	-	4
Dissertation (D)			4	14	18
Seminar (S)	-	-	-	2	2
Total	**18**	**17**	**16**	**16**	**67**

19.5.2018

Curriculum of M.Tech. (Computer integrated Manufacturing)

Junior Year, Semester-I

S.N	Category	Paper Code	Subject Name	L	T	P	Credit
1.	M	MAS-101	Numerical Methods & Engineering Optimization	3	1	2	5
2.	PC	MME-101	Advanced Computer Aided Design	3	1	2	5
3.	PC	MME-102	Computational Methods in Engineering	3	1	0	4
4.	PC	MME-103	Machining Science	3	1	0	4
5.	AC		Audit subject				
			Total	**12**	**4**	**4**	**18**

Junior Year, Semester-II

S.N.	Category	Paper Code	Subject Name	L	T	P	Credit
1.	PC	MME-104	Advanced Computer Aided Manufacturing	3	1	2	5
2.	PC	MME-105	Advance Machining Processes	3	1	0	4
3.	PE1		Program Elective-1	3	1	0	4
4.	PE2		Program Elective-2	3	1	0	4
5.	AC		Audit subject				
			Total	**12**	**4**	**2**	**17**

Senior Year, Semester-III

S.N.	Category	Paper Code	Subject Name	L	T	P	Credit
1.	PE3		Program Elective-3	3	1	0	4
2.	PE4		Program Elective-4	3	1	0	4
3.	MP	MME-120	Minor Project	0	0	8	4
4.	D	MME-130	Dissertation Part-I	0	0	8	4
			Total	**6**	**2**	**16**	**16**

Senior Year, Semester-IV

S.N.	Category	Paper Code	Subject Name	L	T	P	Credit
1.	S	MME-140	Seminar	0	0	4	2
2.	D	MME-150	Dissertation Part-II	0	0	28	14
			Total	**0**	**0**	**32**	**16**

Program Core(Computer Integrated Manufacturing)

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
1.	MAS-101	Numerical Methods & Engineering Optimization	-	3	1	2	5
2.	MME-101	Advanced Computer Aided Design	-	3	1	2	5
3.	MME-102	Computational Methods in Engineering	-	3	1	0	4
4.	MME-103	Machining Science	-	3	1	0	4
5.	MME-104	Advanced Computer Aided Manufacturing	-	3	1	2	5
6.	MME-105	Advance Machining Processes	-	3	1	0	4
7.	MME-120	Minor Project	-	0	0	8	4
8.	MME-130	Dissertation Part-I	-	0	0	8	4

19/5/18

19.8.2018

9.	MME-140	Seminar	-	0	0	4	2
10.	MME-150	Dissertation Part-II	Dissertation Part-I	0	0	28	14

Program Electives (Computer Integrated Manufacturing) *

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
		PE-1& PE-2 (Semester-II)					
1.	MME-151	Machine Tool Design	-	3	1	0	4
2.	MME-152	Design for Manufacture and Assembly	-	3	1	0	4
3.	MME-153	Robotic Engineering	-	3	1	0	4
4.	MME-154	Design of experiments	-	3	1	0	4
5.	MME-155	Micro-Machining and Precision Engineering	-	3	1	0	4
6.	MME-156	Production and Operations Management	-	3	1	0	4
7.	MME-157	Additive Manufacturing	-	3	1	0	4
		PE-3 & PE-4 (Semester-III)					
1.	MME-161	Finite Element Method	-	3	1	0	4
2.	MME-162	Advance material and Characterization	-	3	1	0	4
3.	MME-163	Industrial Automation	-	3	1	0	4
4.	MME-164	Flexible Manufacturing System	-	3	1	0	4
5.	MME-165	Concurrent Engineering & Product Lifecycle Management	-	3	1	0	4
6.	MME-166	Advanced Strength of materials	-	3	1	0	4

Audit Courses for M.Tech. (Computer Integrated Manufacturing)

S.N.	Paper Code	Subject		L	T	P	Credits
		Semester-I					
1.	MAS-105	Applied Probability and Statistics	-	3	1	0	4
2.	BOE-04	Principles of Remote Sensing		2	1	0	3
3.	BOE-07	Introduction to Data and File Structures	-	2	1	2	4
4.	MBA-109	Research Methodology	-	3	1	0	4
		Semester-II					
1.	BAS-27	Discrete Mathematics	-	3	1	0	4
2.	BCE-21	Environmental Impact Assessment & Management	-	3	1	0	4
3.	BCS-73	Neural Network & Fuzzy Systems	-	3	1	0	4
4.	BEE-15	Introduction to Microprocessors	-	3	1	2	5
5.	MBA-106	Human Resource Management	-	3	1	0	4

* Besides above elective subject, students may be offered other elective subjects with prior approval of the Competent Authority.

19/5/18

19.5.2018

Department of Mechanical Engineering

Madan Mohan Malaviya University of Technology, Gorakhpur-273 010, India

M. Tech. (Computer Integrated Manufacturing) Syllabus

MAS-101	NUMERICAL METHODS & ENGINEERING OPTIMIZATION		
Course category	:	Program Core (PC)	
Pre-requisite Subject	:	NIL	
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2	
Number of Credits	:	5	
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination	
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course	
Topics Covered			
UNIT-I			
Numerical Methods: Solution of algebraic and transcendental equations by Bisection, Regula-Falsi and Newton-Raphson methods. Interpolation: Newton's forward and backward interpolation formulae, Lagrange's formula andNewton's divided difference formula. Solution of system of linear equations by Guass-Siedel method and Crout'smethod, Numerical Integration: Trapezoidal Rule, Simpson's one-third and three-eight rules.			9
UNIT-II			
Classical Optimization Techniques: Introduction, Review of single and multi-variable optimization methods with and without constraints, Non-linear one dimensional minimization problems, Examples.			9
UNIT-III			
Constrained Optimization Techniques: Introduction, Direct Methods, Cutting plane method and method of feasible directions, Indirect methods, Convex programming problems, Exterior penalty function method,Examples and problems.			9
UNIT-IV			
Unconstrained optimization techniques: Introduction: Direct search method, Random, Univariate and Patternsearch methods, Rosenbrock's method of Rotating co-ordinates, Descent methods, Steepest Descent methods,Quasi-Newton's and variable metric method			9
EXPERIMENTS **Minimum Eight experiments are to be performed** 1. To implement numerical integration using Simpson's one-third and Simpson's three-eight rules. 2. To implement Gauss-Siedel method for solution of simultaneous equations. 3. To implement Relaxation method for solving simultaneous equations. 4. To implement Runge-Kutta method of order four to solve differential equations. 5. To implement Euler's method to find solution of differential equations. 6. To find optimum solution to problem parameters. 7. To find derivatives of static displacements and stresses. 8. To write Computer based algorithm and program for solution of Eigen-value problems. 9. Reduction of size of an optimization problem using Reduced basis technique. 10.To find Derivatives of Eigen-values and Eigen vectors.			

Books & References	
1.	Engineering Optimization
2.	Applied Optimal Design
3.	Optimization for Engineering Design
4.	Engineering Mathematics

MME-101	**ADVANCED COMPUTER AIDED DESIGN**	
Course category	:	Program Core (PC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one Minor test and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The knowledge of computer graphics system and its hardware such as graphics input, display and output devices.
2. The ability to generate circle and ellipse using Bresenham's algorithm and understand the mathematics behind 3D geometric transformations.
3. Understand analytical representations of different types of parallel such as orthographic, oblique and axonometric projections as well as non parallel such as perspective and stereographic projections.
4. The analytical representations of parametric planar curves and synthetic space curves such as Hermite, Bezier, non rational& rational B-spline curves and their properties.
5. The synthetic surfaces and their parametric representations, different solid modeling techniques and skill of generating 3D geometric models in CAD software.

Topics Covered	
UNIT-I	
Graphic Systems Introduction, Graphics systems, Graphics hardware input devices, Display devices, Color displays, Solid state monitors, Output devices, Software configuration and functions, Graphics software standards **Output Primitives** Scan conversion of primitives, Bresenham's Circle generating algorithm and Ellipse generating algorithms, problems.	9
UNIT-II	
3D Transformation Linear transformations, translation, rotation, scaling, reflection and shear, Matrix representation, Overall scaling, Composite transformations, Rotation about local axes parallel to global axes, Rotation about an arbitrary axis, Scaling with respect to fixed point, Reflection through an arbitrary plane **Projections** Plane geometric projection, Parallel projections–Matrix equations for Orthographic projection, Oblique projection-Cavalier and Cabinet projections, Axonometric projections-isometric, diametric and trimetric	9

projections; Perspective projections-vanishing point, Equation for one point, two point and three point perspective projections, Stereographic projections-monocular and binocular depth perceptions	
UNIT-III	
Curves Classical representation of curves, Parametric analytic curves, Space curves, Hermite curves-Blending functions, properties, Bezier curves-Blending functions, properties, Composite Bezier curves and drawbacks, Non-rational B-spline curves-spline blending functions, blending function formulation, knot vector, uniform, open uniform and non uniform non rational spline blending functions, B-splines curve generation for various control points, Shape control of spline curves, properties, Rational B-spline curves-open uniform, periodic uniform and non uniform knot vector, Conic sections generation	9
UNIT-IV	
Surface Description and Generation Parametric representation, Surfaces of revolution, Sweep surfaces, Bilinear surface, Ruled and developable surfaces, Coons bicubic surfaces, Bezier and B-spline surfaces **3D Graphics** Polygon surfaces-polygon meshes, Wire frame and Solid models-Regularized Boolean set operations, Sweep and boundary representations, Constructive Solid Geometry- unbounded and bounded primitives	9

EXPERIMENTS

Minimum Eight experiments are to be performed

1. Understanding and use of drafting software AutoCAD
2. Sketching and solid modeling of a machine component in CAD software such as ProE/ Solidworks etc.
3. Writing and validation of circle drawing algorithm
4. Writing and validation of ellipse drawing algorithm
5. Writing and validation of computer program for individual geometric transformation such as translation/ rotation/ scaling
6. Writing and validation of computer program for combined geometric transformations such as translation/ rotation/ scaling
7. Writing and validation of computer program for design of shaft under the combined bending and torsional loading
8. Experiments on generation of analytic curves
9. Experiments on generation of space curves
10. Experiments on generation of surfaces
11. Experiments on generation of solid models in CAD software
12. Experiments on projection of an object

Books & References

1. Computer Graphics-Hearn & Baker, Prentice Hall of India
2. Computer Aided Engineering Design-Anupam Saxena & B. Sahay, Anamaya Publishers
3. CAD/CAM Theory and Practice- Ibrahim Zeid& R Sivasubramaniam, McGraw Hill
4. Mathematical Elements for Computer Graphics- DF Rogers & JA Adams, McGraw Hill
5. CAD/CAM-HP Groover & EW Zimmers Jr, Prentice Hall India Ltd
6. Computer Aided Design-S.K. Srivastava, IK International Publications
7. Computer Aided Design-R.K. Srivastava, Umesh Publications

MME-102	Computational Methods in Engineering		
Course Category		:	Program Core (PC)
Pre-requisites		:	NIL
Contact Hours/Week		:	Lecture: 3, Tutorial : 1, Practical: 0
Number of Credits		:	4
Course Assessment Methods		:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one minor test and one major examination
Course Outcomes		:	The students are expected to be able to demonstrate the following knowledge and skills after completing this course

1. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions
2. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
3. Ability to select appropriate numerical methods for various types of problems in engineering.
4. Analyse and evaluate the accuracy of common numerical methods.

Topics Covered

UNIT-I	
Introduction to Linear Algebraic Equation, Roots of Equation, Numerical differentiation and Integration, Initial and boundary value problems. **Systems of Linear Algebraic Equations:** Gauss Elimination Method, LU Decomposition Methods, Interpolation and Curve Fitting: Polynomial Interpolation, Interpolation with Cubic Spline.	9
UNIT-II	
Roots of Equations: Incremental Search Method, Method of Bisection, Methods Based on Linear Interpolation, Newton–Raphson Method, Systems of Equations	9
UNIT-III	
Numerical Differentiation and Integration: FiniteDifferenceApproximations, RichardsonExtrapolation, DerivativesbyInterpolation, Implicit and explicit integration schemes.	9
UNIT-IV	
Initial and Boundary ValueProblems: TaylorSeriesMethod, Runge–KuttaMethods, ShootingMethod.**SymmetricMatrixEigenvalueProblems**.	9

Textbooks

1.	JaanKiusalaas, Numerical Methods in Engineering with Matlab , Second Edition, Cambridge University Press.
2.	Arnold Neumaier, Introduction to Numerical Analysis, , Cambridge University Press.

Reference books

1.	Rao. V. Dukkipati ,MATLAB an Introduction with Application, , New Age Publisher

MME-103	MACHINING SCIENCE	
Course Category	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and one Minor test and One Major Theory
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to understand the mechanics metal cutting, shear angle, chip flow and chip control methods.
2. Ability to apply the concept of Thermodynamics of chip formation, tool wear and tool life.
3. Ability to design and develop Economics of metal cutting-Single and multipass machining operations.
4. Ability to develop methods for defining Dynamic metal cutting, Problems associated with machining of plastics and Analysis of non-conventional machining processes ECM, EDM, LBM, WJM, USM etc.

Topics Covered

UNIT-I	
Mechanics of metal cutting-Tool geometry, Mechanics of orthogonal and oblique cutting, Shear angle relations in orthogonal cutting, Shear angle and chip flow direction in oblique cutting, Chip control methods, Analysis of cutting process, Machining with rotary tools	9
UNIT-II	
Thermodynamics of chip formation, Machining at super high speeds, Theories of tool wear, Basic action of cutting fluids, tool life, Factors governing tool life, Machinability-definition and evaluation.	9
UNIT-III	
Economics of metal cutting-Single and multipass machining operations, Criteria, variables, and restrictions for the economical conditions	9
UNIT-IV	
Dynamic metal cutting-Comparison of steady and dynamic process, Shear angle and force relationships, Grinding mechanics, Wheel characteristics and theory of wheel wear, Lapping, Honning, High speed grinding theory, Grinding of drills, form cutters etc., Problems associated with machining of plastics, Tools for plastic cutting, Analysis of non-conventional machining processes ECM, EDM, LBM, WJM, USM etc.	9

Textbooks

1. Introduction to Machining Science- GK Lal (New Age International)
2. Machining Fundamentals- Walker John R (Goodheart)

Reference books

1. Non-Conventional Machining- P K Mishra (Narosa Publications)
2. Metalwork and Machining Hints and tips (Workshop Practice)- Arnold Throp

MME-104	ADVANCED COMPUTER AIDED MANUFACTURING	
Course Category	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 2
Number of Credits	:	5
Course Assessment	:	Continuous assessment through tutorials, attendance, home assignments,

Methods		quizzes, practical work, record, viva voce and one Minor test and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understanding the implementation of automation in production system and ability to know the role of computer in the area of manufacturing.
2. Ability to design and develop various parts of CNC Machines for improving their effectiveness and implementation of adaptive control.
3. Ability to develop manual part program and computer assisted part program for the production of components
4. Ability to understand the various modules of FMS and apply the concept of group technology and computer assisted process planning.

Topics Covered

UNIT-I	
Introduction: Introduction to CAM, CAD/CAM interface, Introduction to Automation, Historical developments and future trends, automation in production system, automation strategies, advantages and disadvantages of automation, Need of NC system, fundamental of NC machine tool, Classification of NC machine tool, suitability and limitations, applications of NC system.	9
UNIT-II	
Features of CNC Machine Tool: Development in MCU technology, Principle of operation of CNC, standard controllers, Design considerations of CNC machines for improving machining accuracy – structural members, slideways, spindle drive, feed drive, lead screws; Methods for improving productivity , work holding device, automatic tool changer, features of CNC machining centres **Control of CNC Systems:** Open and Closed loop control systems, feedback devices, interpolators, Adaptive control systems.	9
UNIT-III	
CNC Part Programming: Part programming fundamentals, Manual Programming for turning, milling, drilling, etc., Tool length compensation, cutter radius compensation, canned cycle, Do loops, Subroutine and Macro; Concept of computer aided part programming, APT language structure, Geometry, motion and post processor commands, APT part program.	9
UNIT-IV	
FMS, CIMS & CAPP: Building blocks of flexible manufacturing systems (FMS), tool management systems, workpiece handling systems, FMS control, computer integrated manufacturing systems, computer aided process planning- variant and generative process planning.	9

EXPERIMENTS

Minimum Eight experiments are to be performed

1. Study on Retrofitting of Conventional Milling Machine to CNC Milling Machine.
2. To study the characteristics features of CNC lathe trainer (Model SS-PT-100).
3. To study the characteristics features of CNC Turning (XLTURN)
4. To study the characteristics features of CNC Milling (XLMILL)
5. Write a manual part program for turning operations and prepare the component on CNC Turning.
6. Write a manual part program for Grooving and threading operations and prepare the component on CNC Turning.
7. Write a manual part program for Peck drilling operations and prepare the component on CNC Turning.
8. Write a manual part program using linear and circular interpolation for CNC Milling and prepare the component.
9. Write a manual part program for rectangular pocket milling operation for CNC Milling and prepare the component.
10. Study and perform operations of Flexible Manufacturing System.

Textbooks

1.	Automation, Production Systems and Computer Integrated Manufacturing by Mikell P. Groover (PHI)

2.	Computer Control of Manufacturing System by Yoram Koren(McGraw Hill).
3.	Computer Aided manufacturing- P. N. Rao , N. K. Tewari & T. K. Kundra (Tata McGraw Hill).
4.	CAD/CAM/CIM – P. Radhakrishnan, S. Subrmanyam and V. Raju (New Age International)
Reference books	
1.	Principles of Computer Integrated Manufacturing – S. Kant Bajpai (PHI)
2.	Computer Aided Design & Manufacture – C. B. Besant & C. W. K. Lui (East West Press)

MME-105	**ADVANCED MACHINING PROCESSES**	
CourseCategory	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, and one Minor test and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Able to understand the limitations of conventional and need of unconventional processes.
2. Able to understand working principle, mechanics of material removal, and applications of USM, AJM, and MAF.
3. Acquire the knowledge about working principle and applications of EDM, PAM, LBM and EBM.
4. Ability to know about chemical, electrochemical and hybrid unconventional machining processes.

Topics Covered

UNIT-I	
Introduction: Limitations of Conventional machining processes, Need of advanced machining processes and its classifications, Comparison between precision and micro machining, future trends of advanced machining	9
UNIT-II	
Mechanical Type Metal Removal Processes: Ultrasonic machining; Elements of the process; Tool design and economic considerations; Applications and limitations, Abrasive jet and Abrasive water jet machining principles; Mechanics of metal removal; Design of nozzles; applications, Abrasive finishing process, Magnetic abrasive finishing process	9
UNIT-III	
Thermal Type Advance Machining Processes: Classification, General principles and applications of Electro discharge, Plasma arc, Ion beam, Laser beam, Electron beam machining, Mechanics of metal removal in EDM, selection of EDM pulse generator dielectric, machining accuracy, surface finish and surface damage in EDM, Generation and control of electron beam for machining applications, advantages and limitations.	9
UNIT-IV	
Chemical and Electro-chemical Type Metal Removal Processes: Principle, working advantages, disadvantages and applications of Electrochemical, Chemical machining, Economy aspects of ECM, Electro-chemical deburring and honning **Hybrid Unconventional Machining Processes:** Introduction to ECDM, ECAM, Abrasive EDM etc.	9
Textbooks	

1.	Advance Machining Processes- V.K. Jain (New Age)
2.	Modern Machining Processes- P.C. Pandey (New Age)
Reference books	
1.	Manufacturing Processes- Degarmo(McGraw-Hill International)
2.	Manufacturing Processes- Kalpakjian (Tata McGraw-Hill International)

MME-120	**MINOR PROJECT**	
CourseCategory	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 0, Tutorial: 0, Practical: 8
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through attendance, project reports, mid semester presentation and end semester presentation.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understanding of importance of literature survey.
2. Develop ability to comprehend the research paper.
3. Understanding of steps involved in writing the research paper.
4. Develop the ability to write a research paper.

MME-130	**DISSERTATION PART-I**	
Course Category	:	Program Core (PC)
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	Lecture : 0, Tutorial : 0, Practical: 8
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through attendance, project reports, mid semester presentation and end semester presentation.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Analyze and apply prior knowledge to designing and implementing solutions to open-ended computational problems while considering multiple realistic constraints.
2. Analyze the selected topic, organize the content and communicate to audience in an effective manner
3. Analyze Database, Network and Application Design methods
4. Evaluate the various validation and verification methods

MME-140	**SEMINAR**

CourseCategory	:	Program Core (PC)
Pre-requisites	:	-
Contact Hours/Week	:	Lecture: 0, Tutorial: 0, Practical: 4
Number of Credits	:	2
CourseAssessment Methods	:	Continuous assessment through presentations and viva voce
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to understand the working in real environment and get acquainted with the organization structure, business operations and administrative functions.
2. They able to enhance the communications and presentation skills.
3. Ability to evaluate, credit, and synthesize sources.
4. Understanding to write technical documents and give oral presentations related to the work completed.

MME-150	**DISSERTATION PART-II**	
Course category	:	Program Core (PC)
Pre-requisite Subject	:	Dissertation Part-I
Contact hours/week	:	Lecture : 0, Tutorial : 0, Practical: 28
Number of Credits	:	14
Course Assessment Methods	:	Continuous assessment through attendance, project reports, mid semester presentation and end semester presentation.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Synthesizing and applying prior knowledge to designing and implementing solutions to open-ended computational problems while considering multiple realistic constraints.
2. Analyze the selected topic, organize the content and communicate to audience in an effective manner
3. Analyze Database, Network and Application Design methods
4. Evaluate the various validation and verification methods
5. Analyzing professional issues, including ethical, legal and security issues, related to computing projects

MME-151	**MACHINE TOOL DESIGN**	
Course Category	:	Program Electives (PE)
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one Minor test and One Major Theory examination.

Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Design different machine tools considering static and dynamic loads.
2. Familiar with various attachments, equipment's and machine tools required for metal cutting processes
3. Able to select/optimize various machining parameters
4. Understand effect of vibrations on life of machine tools.
5. Understand design considerations for Special features in Machine tools.

Topics Covered

UNIT-I	
Machine Tool Drive: working and auxiliary motion in machine, Machine tool drives, Hydraulic transmission, Mechanical transmission, General requirements of machine tool design, Layout of machine tools. **Regulation of Speed and Feed Rates:** Aim of speed feed regulation, stepped regulation of speed, design of speed box, Design of feed box, Special cases of gear box design, Set stopped regulation of speed and feed rates.	9
UNIT-II	
Design of Machine Tool Structure: Fundamentals of machine tool structures and their requirements, Design criteria of machine tool structure, Static and dynamic stiffness, Design of beds and columns, Design of housing models, Techniques in design of machine tool structure.	9
UNIT-III	
Design of Guide-ways and power Screws: Function and type of guide-ways, design of slide-ways, Protecting devices for slide-ways, Design of power screws.	9
UNIT-IV	
Design of Spindles and Spindle Supports: Materials for spindles, Design of spindles, Antifriction bearings, sliding bearings. **Dynamics of Machines Tools:** General procedure of assessing dynamic stability of EES, Cutting processing, closed loop system, Dynamic characteristics of cutting process, Stability analysis.	9

Books & References

1. Machine Tool Design- N.K. Mehta (Tata McGraw Hill)
2. Machine Tool design Handbook (CMTI Bangalore)
3. Design of Machine Tools- S. K. Basu& D Pal (Oxford University Press)
4. Machine Tools & Tool Desig –P.C. Sharma (S. Chand Publishing)

MME-152	DESIGN FOR MANUFACTURE AND ASSEMBLY	
Course Category	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and one Minor test and One Major Theory examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following

		knowledge, skills and attitudes after completing this course

1. Understand the quality aspects of design for manufacture and assembly.
2. Apply the concept of DFM for casting, welding, forming and assembly.
3. Identify the design factors and processes as per customer specifications.
4. Apply the DFM method for a given product.

Topics Covered

UNIT-I	
Introduction to DFMA: History of DFMA, Steps for applying DFMA during product design, Advantages of applying DFMA during product design, Reasons for not implementing DFMA, Traditional design and manufacture Vs concurrent engineering, DFA index, poke-yoke, lean principles, DFMA as the tool for concurrent engineering, three DFMA criteria for retaining components for redesign of a product. **Introduction to Manufacturing Process:** Classification of manufacturing process, Basic manufacturing processes, Mechanical properties of material: Tensile properties, Engineering stress-strain, True stress strain, Compression properties, Shear properties, Introduction to materials and material selection: Classification of engineering materials, Material selection for product design.	9
UNIT-II	
Metal Casting: Appraisal of various casting processes, Selection of casting process, General design considerations for casting – Use of Solidification Simulation in casting design – Product design rules for sand casting. **Forging**: Design factors for Forging – Closed die forging design – Location of parting lines of dies – Drop forging die design – General design recommendations. **Extrusion, Sheet Metal Work & Plastics:**Design guidelines for Extruded sections - Keeler Goodman Forming Limit Diagram -Component Design for Blanking. Plastics: Viscoelastic and Creep behavior in plastics – Design guidelines for Plastic components. Injection moulding: Typical characteristics of injection moulded parts, Effect of shrinkage, Suitable materials, Design recommendations. **Design for powder metal processing:** Introduction to powder metal processing, Typical characteristics and applications, Limitations, Design recommendations.	9
UNIT-III	
Machining Process: Overview of various machining processes – general design rules for machining -Dimensional tolerance and surface roughness – Design for Machining ease – Redesigning of components for machining ease with suitable examples, General design recommendations for machined parts **Metal Joining:** Appraisal of various welding processes, Factors in design of weldments – General design guidelines – pre and post treatment of welds – Effects of thermal stresses in weld joints – Design of brazed joints. Design for adhesively bonded assemblies: Introduction, Typical characteristics, Suitable materials, Design recommendations for adhesive joint.	9
UNIT-IV	
Design for Assembly: The assembly process, Characteristics and applications, Example of common assembly, Economic significance of assembly, General taxonomies of assembly operation and systems, Developmentof Systematic DFA Methodology, Assembling a product, Design for Assembly: Introduction, Design consideration, Design for Fasteners: Introduction, Design recommendation for fasteners.	9

Textbooks

1.	Geoffrey Boothroyd, Peter Dewhurst and Winston Knight (2002) Product Design forManufacture and Assembly, Second Edition, CRC press, Taylor & Francis, Florida,USA
2.	George E. Deiter, Engineering design-Material & Processing Approach, Mc. Graw Hill, Intl. 2nd Ed.2000.
3.	Handbook of Product Design for Manufacture: A Practical Guide to Low Cost Production- J.G. Bralla (McGraw Hill)

Reference books

1.	A.K Chitale and R.C Gupta, Product design and Manufacturing / A.K Chitale,Prentice – Hall of India,New Delhi, 2003.
2.	Fundamental of Design and Manufacturing, G.K. Lal, Vijay Gupta, N.V.Reddy, Alpha Science Int Ltd.
3.	Surender Kumar &Goutham Sutradhar ,Design and Manufacturing, Oxford & IBH,Publishing Co. Pvt.Ltd., New Delhi, 1998.

MME-153	ROBOTIC ENGINEERING	
Course Category	:	Program Elective (PE)
Pre-requisites	:	----
Contact Hours/Week	:	Lecture : 3, Tutorial : 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, One Minor test and One Major Theory
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to understand the Classification of Robots, Robot specifications, applications and Robot Sensors.
2. Ability to solve problems related to Manipulator kinematics, modeling of mechanical systems and elements.
3. Ability to solve problems related to Manipulator dynamics.
4. Ability to design and develop various Robot Control and robot programming for welding, material handling.

Topics Covered	9
UNIT-I **Introduction** Definition, Classification of Robots, Geometric classification and control classification, Robot Components-manipulator, controller and its elements, sensory devices, Functions of a robot system, Robot specifications and applications, **Robot Sensors** Introduction, Classification, Non-optical position sensors, Optical position sensors, Velocity sensors, Acceleration sensors, Contact and non-contact type proximity sensors.	9
UNIT-II **Manipulator Kinematics** Position and orientation of a rigid body, Homogeneous coordinates, Coordinate transformations-translational, rotational, Matrix operators, Coordinate reference frames, Homogeneous transformations and the manipulator, forward solution, inverse solution, Representation of joints, link representation using D-H parameters. **Mechanical Systems: Components, Dynamics and Modeling** Introduction, Linear motion, Rotational motion, Moment of Inertia-calculation and measurement, Mechanical work and power, Motion conversion, Rotary-to-rotary motion, Rotary-to-linear motion, Problems with real world components, Modeling of mechanical systems, elements, and examples.	9
UNIT-III **Jacobians: Velocities, Static Forces** Examples of D-H parameters and link transforms, Velocity analysis, linear and rotational velocity of rigid bodies, velocity propagation, Jacobians, Singularities, velocity transformation and inverse velocity and acceleration, force transformation and inverse force, examples. **Manipulator Dynamics** Introduction, Lagrange's equation kinetic and potential energy. Link inertia, Tensor, link Jacobian Manipulator inertia tensor. Newton - Euler formulation, Lagrange - Euler formulation, problems.	9
UNIT-IV **Robot Control: Linear, Nonlinear and Force Control** Control Techniques, Dynamics Systems, Transfer Function and State-Space Representation, Performance and stability of Feedback Control, Closed-loop control in position servo, Effect of friction and gravity, DC servomotor, position with no friction or gravity, position with nonzero friction and/or gravity, PID Control, State-Feedback Control, Joint Controllers. Control of a moving block, Multivariable Robot Control, Stability of Multi-DOF Robot. PD Position Control, Inverse Dynamic Control, Force control.	

Robot Programming

Robot control sequencing, Language based programming, Program algorithm, examples, VAL language, robot programming for welding, machine tools, material handling etc.

Textbooks

1.	Introduction to Robotics, S.K. Saha, McGraw Hill Publication
2.	Robotics: Fundamental Concepts and Analysis, Ashitava Ghosal, Oxford University Press
3.	Robot Dynamics and Control, Mark W. Spong, M. Vidyasagar, John Wiley & Sons
3.	Robotic Engineering-R.D. Klafter, T.A. Chmielewski and M. Negin, Prentice-Hall International
2.	Robotics – K.S. Fu, R.C. Gonzalez & CSG Lee, McGraw Hill International
3.	Robotics-K.C. Jain and L.N. Aggrawal, Khanna Publishers
4.	Robotics for Engineers- Y. Koren, McGraw Hill
5.	Introduction to Robotics – J.J. Craig, Pearson Education

Reference books

1.	Robotic Technology-Phillipe Collet, Prentice Hall of India
2.	An Introduction to Robot Technology- Coiffet and Chirooza, Kogan Page
3.	Robots & Manufacturing Automation – Asfahl , Wiley Eastern
4.	Industrial Robots- Groover, Mitchell Weiss, Nagel Octrey- McGraw Hill
5.	Robotics Technology and Flexible Automation, S.R. Deb and S. Deb, McGraw Hill Education

MME-154	**DESIGN OF EXPERIMENTS**	
Course Category	:	Program Electives (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and One Minor test and One Major Theory examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. Also, able to plan, design and conduct experiments efficiently and effectively, and analyse the resulting data to obtain objective conclusions. Both design and statistical analysis issues are discussed.

1. Understanding of western and Taguchi quality philosophy and steps involved in robust design.
2. Understanding of classical and factorial experiments and experimental design.
3. Opportunities to use the principles taught in the course arise in all phases of engineeringwork, including new product design and development, process development, & manufacturing process improvement.
4. Ability to analyse and interpret the experimental data using ANOVA and regression analysis.
5. Understanding of Taguchi's orthogonal arrays and Signal to Noise ratio, parameter design and tolerance design.

Topics Covered

UNIT-I	
Quality Control and Experimental Design: Quality assurance & Total Quality control, Basic statistical concepts, Control of accuracy and precision, Quality Engineering System. Western and Taguchi quality philosophy, Elements of cost, Noise factors causes of variation, Quadratic loss function and variation of quadratic loss functions.	9

Robust Design: Steps in robust design: parameter design and tolerance design, its application to control of processes with high variability reliability improvement through experiments,Illustration through numerical examples. Software applications and case studies	
UNIT-II	
ExperimentalDesign: Introduction and application of experimental design, single factor experiments, randomized blocks, Latin square designs and extensions. Fractional factorial designs, two-level, three-level and mixed-level factorials and fractional factorials, applications to quality control problems., factor effects, factor interactions, Fractional factorial design, Saturated design, Central composite designs, Illustration through numerical examples.	9
UNIT-III	
Analysis and Interpretation of Experimental Data: Measures of variability, Ranking method, column effect method and plotting method, Analysis of variance (ANOVA), parameter optimization. Mathematical models from experimental data, illustration through numerical examples.Repeated measures design, analysis of covariance and its applications in comparing alternatives.	9
UNIT-IV	
Taguchi's Orthogonal Arrays: Types orthogonal arrays, Selection of standard orthogonal arrays, Linear graphs and interaction assignment, dummy level technique, Compound factor method, modification of linear graphs,Strategies for constructing orthogonal arrays. **Signal to Noise ratio (S-N Ratios):**Evaluation of sensitivity to noise, Signal to noise ratios for static problems, STB,NTB,LTB – type criteria. **Parameter Design and Tolerance Design:** Parameter and tolerance design concepts, Taguchi's arrays, Parameter and tolerance design strategy, Illustrations through numerical examples.	9

Textbooks	
1.	M. S. Phadake - Quality Engineering using Robust Design, Prentice Hall, Englewood Clifts, New Jersey, 1989.
2.	Douglas Montgomery, Design and analysis of experiments, Willey India Pvt. Ltd., 5th Edition, 2007.
3.	P. J. Ross, Taguchi, Techniques for Quality Engineering, 2nd Edition. McGraw Hill Int. Edition, 1996.
4.	Sharma M K, Design and Analysis of Experiments, 2012, Prentice Hall India Learning Private Limited.
5.	Winer BJ, 1962, Statistical Principles in Experimental Design, 2nd Edition, McGraw-Hill
Reference books	
1.	T. B. Barker, M. Dekker, Quality by Experimental Design, Inc ASQC Quality Press, 1985
2.	Quality Control and Applications - B.L. Hansen & P.M. Ghare (Prentice Hall of India)
3.	C. F. Jeff Wu, Michael Hamada, Experiments planning, analysis and parameter design optimization, John Willey Ed., 2002.
4.	W. L. Condra, Marcel Dekker, Reliability improvement by Experiments, Inc ASQC Quality Press, 1985.
5.	Hinkelmann K and Kempthorne, O, 1994, Design and Analysis of Experiments (Vol I), Wiley.

MME-155	**MICRO-MACHINING AND PRECISION ENGINEERING**	
Course Category	:	Program Electives (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work record, viva voce and one Minor test and One Major Theory examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following

		knowledge, skills and attitudes after completing this course

1. The importance of micromachining technologies by studied characterization of micro-machining, Tool making, Micro-machinability of materials, LIGA and Diamond micro-machining etc.
2. The Different machining principle of micro EDM, micro-WEDG, micro-ECM, hybrid micro-machining method, on-line measurement by machine vision and integrated probe.
3. Different Abrasive micromachining and micro grinding behavior of materials surface by Laser micromachining, laser micro-drilling, laser micro-adjustment, and laser surface structuring etc.
4. The different concepts regarding Micro-machining by finishing techniques by scanning tunneling microscopes, atomic force microscope, elastic transmission method, computer aided measurement testingetc.

Topics Covered	
UNIT-I	
Introduction to micromachining technologies, bulk micromachining, LIGA, Surface Micromachining,Characterization of micro-machining, Tool making, Micromachinability of materials, Diamond micro-machining: machining principles, diamond turning, diamond grinding, accuracy and dimensional control, , future trends in ultrahigh speed machining	9
UNIT-II	
Microelectro discharge Machining: Principles of micro-EDM, micro-EDM by Die-sinking and WEDG, micro-WEDM, micro-WEDG, micro-ECM, Principles of micro-turning, micro-drilling and micro-milling, hybrid micro-machining method, on-line measurement by machine vision and integrated probe.	9
UNIT-III	
Abrasive micromachining and micro grinding: Abrasive micromachining mechanisms, micro-grinding mechanism, micro-machining rate, micro-machining cooling media;Laser micromachining: Principles of laser material removal, laser micro-drilling, laser micro-adjustment,laser surface structuring, laser micro-cutting.	9
UNIT-IV	
Micro-machining by finishing techniques: micro-lapping, microhoning, magneto-abrasive micromachining and finishing (MAF), ELID Grinding, Measuring Techniques in micro-machining: stylus instruments, scanning tunneling microscopes, atomic force microscope, measurement of micromoles and slots using optical method, elastic transmission method, computer aided measurement testing, surface integrity and other related measurements	9

Textbooks	
1.	J. M. Geough, Micro-machining of Engineering Materials, Edited by Marcel Dekker, 2002
2.	R.W. Johnstone, M. Parameswaran, An introduction to surface-micromachining, Kluwer Academic Publishers, 2004
3.	N. P Mahalik. Micro-manufacturing and nano-technology, edited by, Springer Publication, 2006
4.	M. P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, 2003
Reference books	
1.	J. M. Geough, Micro-machining of Engineering Materials, Edited by Marcel Dekker, 2002
2.	N. P Mahalik. Micro-manufacturing and nano-technology, edited by, Springer Publication, 2006

MME-156	**PRODUCTION AND OPERATIONS MANAGEMENT**	
CourseCategory	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4

Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, One Minor test and One Major Theory examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to understand the Operations strategy, forecasting method, MRP type systems, Embedding JIT into MRP.
2. Ability to solve problems of Scheduling & control functions, Simulation methodology and Two assembly simulation.
3. Ability to develop various Design of Facilities & Jobs, JIT implementation, Considerations in job design, Work measurements and standards.
4. Ability to apply the concept of Product Design & Process Selection.
5. able to understand the basics of material management and inventory.

Topics Covered

UNIT-I	
Introduction: Operations strategy, Framework for operations strategy in manufacturing. Selection of forecasting method, Focus forecasting, Aggregate planning techniques, Inventory systems for independent demand, **Operations Scheduling:** Scheduling & control functions, Priority rules and techniques, Single machine scheduling problems, Scheduling in jobs on 'm' machines, Personal scheduling.	9
UNIT-II	
Design of Facilities & Jobs: Strategic capacity planning concepts, determining capacity requirements, Planning service capacity, JIT production systems, JIT implementation requirements, Facility and Plant location methods, Facility, Process and Product layout, GT layout, Retail service layout, Computer aided layout techniques, Job design and work measurement, Work measurements and standards. **Product Design & Process Selection:** Product design process, Designing for the customer QFD, Value analysis, designing products for manufacturer & assembly, Choosing from alternative processes & equipment, Virtual factory, Waiting line management & models.	9
UNIT-III	
Static Inventory Models: Static inventory models under uncertainty, decision criteria for inventory problems MRP type systems. **Dynamic Inventory Models:** Dynamic inventory problems under risk and under uncertainty; Multi-stage inventory problems; Materials Requirement Planning (MRP), Inputs, Outputs, MRP computation, EOQ-MRP comparisons; MRP types	9
UNIT-IV	
Simulation: Simulation methodology and categories; Monte-Carlo simulation; perpetual inventory; Periodic simulation problems; Simulation of joint probability distribution. **Inventory Control systems:** Types of control systems; Selective inventory control; Inventory system development, Excess materials; Inventory system improvement; Aggregate inventory measurement.	9

Textbooks

1. Production and Operations management- Adam & Ebert (Prentice Hall India)
2. Operations management- Buffa (John Wiley)
3. Operations management- Starr (Prentice Hall)
4. Inventory Management - D. Chandra Bose (Prentice Hall of India)

Reference book

1. Materials Management: An Integrated Approach - P. Gopalakrishnan & M. Sundersan (Prentice Hall of India)

MME-157	ADDITIVE MANUFACTURING		
Course Category	:	Program Elective (PE)	
Pre-requisites	:	NIL	
Contact Hours/Week	:	Lecture : 3, Tutorial : 1, Practical: 0	
Number of Credits	:	4	
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one Minor test and One Major Theory examination.	
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge and skills after completing this course	
5. Ability to understand the fundamental of Additive manufacturing and its varieties like liquid based, solid based and powder-based AM technologies, their potential to support design and manufacturing. 6. Ability to understand the various types of Pre-processing, processing, post-processing errors in AM and to acknowledge the various types of data formats and software's used in AM. 7. Ability to demonstrate the applications of AM in design analysis, aerospace, automotive, biomedical and other fields and research challenges associated with AM.			
Topics Covered			
UNIT-I			
Introduction: Need for Additive Manufacturing, Development of AM systems, AM Process Chain, commonly used Terms, Impact of AM on product development, Virtual prototyping, Rapid tooling, Rapid prototyping to AM, Classification of AM process, Advantages and Limitations, Applications of AM-Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Medical and Bioengineering, Web Based Rapid Prototyping Systems etc.			9
UNIT-II			
Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Working principle, Pre-build process, part building and post building processes, photo polymerization SL resin, part quality and process planning, recoating issues, advantages, limitations and applications. Case studies. Solid Ground Curing (SGC): Working principle, Process, Applications, Advantages and Disadvantages, Case studies. Polyjet: working principle, Process, Applications, Advantages and Disadvantages, Case studies. **Solid-based AM Systems:** Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies. Fused Deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Case studies. Multi-Jet Modelling (MJM): working principle, Process, Applications, Advantages and Disadvantages, Case studies.			9
UNIT-III			
Powder Based AM Systems: Selective laser sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Case studies. Laser Engineered Net Shaping (LENS): Process, working principle, Applications, Advantages and Disadvantages, Case studies. **Other Additive Manufacturing Systems:** Three-dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based, and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballistic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.			9
UNIT-IV			
AM Data Formats: Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly			9

Proposed Formats. Mesh Refining by Sub division Techniques. **AM Software's:** Need for AM software, Features of various AM software's like MAGICS, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, 3-matic, MeshLab.	

Textbooks	
1.	Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2.	Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
3.	Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
Reference books	
1.	Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

MME-161	**FINITE ELEMENT METHOD**	
Course category	:	Program Electives (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce , one major test and one major examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To develop the ability to generate the governing finite element equations for systems governed by partial differential equations.
2. To understand the use of the basic finite elements for structural applications using truss, beam, frame and plane elements;
3. To understand the application and use of the finite element method for heat transfer problems.
4. To demonstrate the ability to evaluate and interpret Finite Element Method analysis results for design and evaluation purposes.
5. To develop a basic understanding of the limitations of the Finite Element Method and understand the possible error sources in its use.

Topics Covered	
UNIT-I	
Introduction: Historical background,basic concepts of FEM, Comparison with Finite Difference Method, Advantages and limitations, Different approaches in Finite Element Method-Discrete, Variational approach, Weighted Residual methods.	9
UNIT-II	
Direct Problems- Spring, Hydraulic Network; Resistance Network and Truss Systems **Finite element analysis of 1-D problems:** formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its postprocessing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame.	9
UNIT-III	
Finite element analysis of 2-D problems: Finite Element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics;	9
UNIT-IV	
Numerical considerations: numerical integration, error analysis, mesh refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems;	9

Discussion about preprocessors, postprocessors and finite element packages.
Books & References
1. An Introduction to Finite Element Method – J. N. Reddy (Tata McGraw Hill). 2. Finite Element Procedure in Engineering Analysis - K.J. Bathe (Tata McGraw Hill). (New Central book Agency) 3. Concepts and Application of Finite Element Analysis- R.D. Cook, D.S. Malcus and M.E. Plesha (John Wiley) 4. Introduction to Finite Elements in Engineering- T.R Chandrupatla and A.D. Belegundu (Prentice Hall India) 5. Numerical Methods– E. Balagurswamy (Tata Mc Graw Hill)

MME-162	**ADVANCE MATERIAL & CHARACTERIZATION**	
CourseCategory	:	Program Electives(PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Ability to understand the role of computer in the areas of automation, planning and manufacturing for improving their effectiveness.
2. Ability to develop manual part program and computer assisted part program to produce components.
3. Ability to design and develop various system such as feedback, interpolator, material handling and implementation of adaptive control.
4. Ability to apply the concept of group technology and computer assisted process planning.

Topics Covered	
UNIT-I	
Materials and Classification: Introduction, Demand of advanced materials,Classification of different materials and alloys. Macro and micro analysis of materials, Segregation and bonding, Strengthening mechanisms.	9
UNIT-II	
Properties of Materials: Flexural Test,Toughness tests, Creep characteristics, Hardness tests, Fracture test, Griffith's crack theory, Strain hardening, Single crystal growth. **Wear:** Modes of adhesive, abrasive, erosive, fretting, sliding.	9
UNIT-III	
Techniques of Materials Characterization: Definition; importance and application of X-ray diffraction technique for phase identification,Scanning Electron Microscope; Principles of image formation in SEM, Energy dispersive X-ray analysis, Thermo-mechanical behavior of composites materials, DSC, AFM.	9
UNIT-IV	
Modern Materials and Alloys: Super alloys-refractory materials, Shape memory alloys, Advanced Composites-Particulate and dispersion composites, Metal matrix and Ceramic matrix composites, Nano materials, Polymers and polymerization, Engineering applications of different materials.	9
Textbooks	
1. Engineering Materials and Applications, P. Flinn and P.K. Trojan, MIR Publications	

2.	Engineering Materials: Polymers, Ceramics and Composites, A.K Bhargava, Prentice Hall of India
3.	Manufacturing processes for Engineering Materials, SeropeKalpakjian, Wesley Publishing Co.
4.	An introduction to Physical Metallurgy, S.H. Avner, McGraw Hill
5.	Advances in Materials and Their Applications, P. Rama Rao, Wiley Eastern
6.	Mechanical Metallurgy, Dieter, McGraw Hill
7.	Material Science & Engineering, W.D. Callister, Jr, Wesley Publishing Co.
Reference books	
1.	Mechanical Metallurgy, Dieter, McGraw Hill
2.	Material Science & Engineering, W.D. Callister, Jr, Wesley Publishing Co.

MME-163	**INDUSTRIAL AUTOMATION**	
Course Category	:	Program Electives (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture : 3, Tutorial : 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to identify and explain potential areas of automation in manufacturing.
2. Ability to differentiate the various control aspects of automation.
3. Ability to design components and systems related to industrial automation considering the economic, social, manufacturability and sustainability aspects

Topics Covered	
UNIT-I	
Introduction to Automation Automation in production system, Mechanization and automation, Types of automation, Principles and strategies of Automation, Basic elements of an automated system, Levels of automations, Advanced Automation Function, Mechanical, electrical, hydraulic and Pneumatic automation devices and controls, Economics of automation. **Control Technologies in Automation:**Industrial Control Systems, Process Industries Versus Discrete-Manufacturing Industries, Continuous Versus Discrete Control, Automatic Process Control, Building Blocks of Automation Systems, Distributed Control System: Functional Requirements & Configurations.	9
UNIT-II	
Automated Production Lines: Components of a manufacturing system, Single station manufacturing cells, Manual Automated Flow lines, Methods of Work-part Transport, Transfer Mechanism, Buffer Storage, Automation for Machining Operations, Design and Fabrication Considerations, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines.	9
UNIT-III	
Automated Assembly Systems & Line balancing: Fundamentals, The Assembly Process, Assembly Systems, Analysis of Assembly systems, Manual Assembly Lines, The Line Balancing Problem, Methods of Line Balancing, Flexible Manual Assembly Lines. Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of a Single Station Assembly Machine, Analysis of Multi-station Assembly Machines.	9
UNIT-IV	
Automated Inspection and Testing:	9

Inspection and testing, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods. The Future Automated Factory: Trends in Manufacturing, The Future Automated Factory, Human Workers in the Future Automated Factory, The social impact.		
Textbooks		
1.	Mikell P.Grover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education Asia..	
2.	Malov and Ivanov, Principles of Automation & Automated Production Process, Mir Publication.	
3.	Oates and Georgy Newness, Automation in Production Engineering.	
Reference books		
1.	Buzacott& shanty Kumar, Stochastic Models of Manufacturing Systems, Prentice Hall India	
2.	K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill.	
3.	YoremKoren, "Computer control Manufacturing Systems", McGraw Hill, 1999.	

MME-164	**FLEXIBLE MANUFACTURING SYSTEM**	
CourseCategory	:	Program Electives (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture : 3, Tutorial : 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The understanding about factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS,Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment.
2. Ability to know about the concept of GT, Part family formation-coding and classification systems, mathematical programming and graph theoretic model approach for part grouping, Cellular vs. FMS production.
3. Ability to understand CAPP system: Importance, principle of Generative CAPP system.
4. Ability to understand the concept of Quantitative methods, Implementation techniques for CAPP, criteria for selecting a CAPP system and benefits of CAPP

Topics Covered	
UNIT-I	
Basics of FMS: Introduction and classification of FMS, Automated production cycle, Need, concept and measurement of flexibility, Types of flexibilities and its measurement,Economic justification and Functional requirements of FMS, FMS processing and quality assurance equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, AMHS equipment, cutting tool and tool management, Future trends of Flexible Manufacturing System.	9
UNIT-II	
Group Technology: Introduction of GT, Part family formation-coding and classification systems; Part-machine	9

group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping. Determination of machining parameters:effect of parameters on production rate, cost andsurface quality, different approaches, advantages of mathematical approach over conventional approach,solving optimization models of machining processes.	
UNIT-III	
Brief of FMS software and FMS Simulations Structure and function of FMS software, simulations process, model of a Flexible manufacturing system, simulation software, limitations of simulations **Data bases in Flexible Manufacturing systems and its implementation** Manufacturing data systems, manufacturing data flow, computer-aided design and manufacturing considerations when planning for FMS, Implementation objectives, acceptance testing, Performance goals and expectation, maintenance	9
UNIT-IV	
Introduction to CAPP: Role of process planning,advantages of conventional process planning over CAPP, Generative CAPP system: Importance, principle of Generative CAPP system. **Determination of manufacturing tolerances**: Methods of toleranceallocation, sequential approach, integration of design and manufacturing tolerances. Determination of optimal index positions for executing fixed sequence, Quantitative methods.	9

Textbooks	
1.	Handbook of Flexible Manufacturing System – Editor:Nand K. Jha (Academic Press, San Diego,California)
2.	Automation, Production System & Computer Integrated Manufacturing-Groover (PHI)
3.	Flexible Manufacturing System – Wernecks (Spring- Verlag)
4.	FMS in Practice – Boncttо (Northox Ford)
5.	Flexible Manufacturing Cells and systems – W. W.Luggen (PHI)
6.	Performance Modelling of Automated Manufacturing Systems –Vishwanathan&Narahari (PHI)
7.	Computer Aided manufacturing- P. N. Rao , N. K. Tewari& T. K. Kundra (Tata McGraw Hill).
8.	CAD/CAM- P. N. Rao(Tata McGraw Hill)
9.	Mikell P. Groover, Automation, Production systems and Computer Integrated Manufacturing System, Prentice Hall, 2007.
Reference books	
1.	Handbook of Flexible Manufacturing System – Editor:Nand K. Jha (Academic Press, San Diego,California)
2.	Automation, Production System & Computer Integrated Manufacturing-Groover (PHI)
3.	Performance Modelling of Automated Manufacturing Systems –Vishwanathan&Narahari (PHI)
4.	Mikell P. Groover, Automation, Production systems and Computer Integrated Manufacturing System, Prentice Hall, 2007

MME-165	**CONCURRENT ENGINEERING & PRODUCT LIFECYCLE MANAGEMENT**	
Course Category	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture : 3, Tutorial : 1, Practical: 0
Number of Credits	:	4

Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, Three Minor tests and One Major Theory examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to understand the fundamentals of Concurrent Engineering, CE tool box and Collaborative product development.
2. Ability to apply the concept of IT support, Solid modeling, Product data management, Artificial Intelligence.
3. Ability to design and develop various Design Stage such as Lifecycle design of products, CE in optimal structural design, Importance of PLM, Implementing PLM, Responsibility for PLM etc.
4. Ability to understand Components of PLM, Product organizational structure, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards.

Topics Covered

UNIT-I	
Introduction: Extensive definition of Concurrent Engineering (CE), CE design methodologies, Review of CE techniques like DFM (Design for manufacture), DFA (Design for assembly), QFD (Quality function deployment), RP (Rapid prototyping), TD (Total design), for integrating these technologies, Organizing for CE, CE tool box, Collaborative product development.	9
UNIT-II	
Use of Information Technology: IT support, Solid modeling, Product data management, Collaborative product commerce, Artificial Intelligence, expert systems, Software hardware component design.	9
UNIT-III	
Design Stage: Lifecycle design of products, Opportunities for manufacturing enterprises, Modality of concurrent engineering design, Automated analysis Idealization control, CE in optimal structural design, Real time constraints. **Need for PLM:** Importance of PLM, Implementing PLM, Responsibility for PLM, Benefits to different managers, Components of PLM, Emergence of PLM, Lifecycle problems to resolve, Opportunities to seize.	9
UNIT-IV	
Components of PLM: Components of PLM, Product lifecycle activities, Product organizational structure, Human resources in product lifecycle, Methods, techniques, Practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards.	9

Textbooks

1.	Concurrent Engineering in Product Design and Development- I Moustapha(New Age International)
2.	Concurrent Engineering Fundamentals: Integrated Product Development - Prasad (Prentice hall India)
3.	Product Lifecycle Management - John Stark (Springer-Verlag, UK)
4.	Product Lifecycle Management- Michael Grieves (McGraw Hill)

Reference books

1.	Concurrent Engineering: Automation tools and Technology - Andrew Kusiak (Wiley Eastern)
2.	Design for Concurrent Engineering- J. Cleetus (CE Research Centre, Morgantown)
3.	Integrated Product Development- M.M. Anderson and L Hein (IFS Publications)

MME-166	**ADVANCED STRENGTH OF MATERIALS**	
Course Category	:	Program Electives(PE)
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	Lecture : 3, Tutorial : 1, Practical: 0
Number of Credits	:	4
Course Assessment	:	Continuous assessment through tutorials, attendance, home assignments,

Methods		quizzes, practical work, record, viva voce and one Minor test and One Major Theory examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To provide a thorough understanding of advanced topics concerning the response of materials and structural elements to applied forces of deformation.
2. Students should obtain an understanding of advanced strength of materials principles and practices that should assist them in making informed design decisions and solving complex problems.
3. To acquaint with energy methods to solve structural problems.

Topics Covered

UNIT-I

Stress 9

Definition of Stress, Body Force, Surface Force and Stress Vector, Normal and Shear Stress Components, Rectangular Stress Components, The Stress Tensor - 3-D, The Stress Tensor is a Linear Transformation - the Cauchy Tetrahedron, Variation of the Stress Tensor from Point to Point in a Body in Equilibrium Equations of Equilibrium, Coordinate Changes and the Stress Tensor 6. Principal Stresses 7. Octahedral Stresses

Strain

Definition of Strain, Deformation in the Neighbourhood of a Point, Change in Length of a Linear Element—Linear Components,Rectangular Strain Components, Change in the Angle between Two Line Elements, Lagrangian and Eulerian Coordinate Systems and Equations of Compatibility, Strain Deviator and its Invariants

UNIT-II

Stress - Strain Relations 9

Introduction, Generalised Statement of Hooke's Law, Stress–Strain Relations for Isotropic Materials,Modulus of Rigidity,Bulk Modulus,Young's Modulus and Poisson's Ratio, Relations between the Elastic Constants, Displacement Equations of Equilibrium.

Linear Elasticity

Boundary Conditions and 15 equations of elasticity, Two-Dimensional Problems - plane stress and plane strain problems, Airy Stress Function, Techniques for Solving the Equations of Elasticity, Linear Thermoelasticity, Polar Coordinates -Thick-walled Cylinders,The Airy Stress Function in Polar Coordinates

UNIT-III

Applications of Linear Elasticity and Its Approximations 9

Torsion-Introduction, Torsion of Generai Prismatic Bars–Solid Sections, Alternative Approach, Torsion of Circular and Elliptical Bars, Torsion of Equilateral Triangular Bar, Torsion of Rectangular Bars, Membrane Analogy, Torsion of Thin-Walled Tubes, Torsion of Thin-Walled Multiple-Cell Closed Sections, Torsion of Bars with Thin Rectangular Sections, Torsion of Rolled Sections, Multiply Connected Sections

Bending of Beams

Introduction, Straight Beams and Asymmetrical Bending,Regarding Euler–Bernoulli Hypothesis, Shear Centre or Centre of Flexure, Shear Stresses in Thin-Walled Open Sections: Shear Centre, Shear Centres for a Few Other Sections, Bending of Curved Beams (Winkler-Bach Formula), Deflections of Thick Curved Bars

UNIT-IV

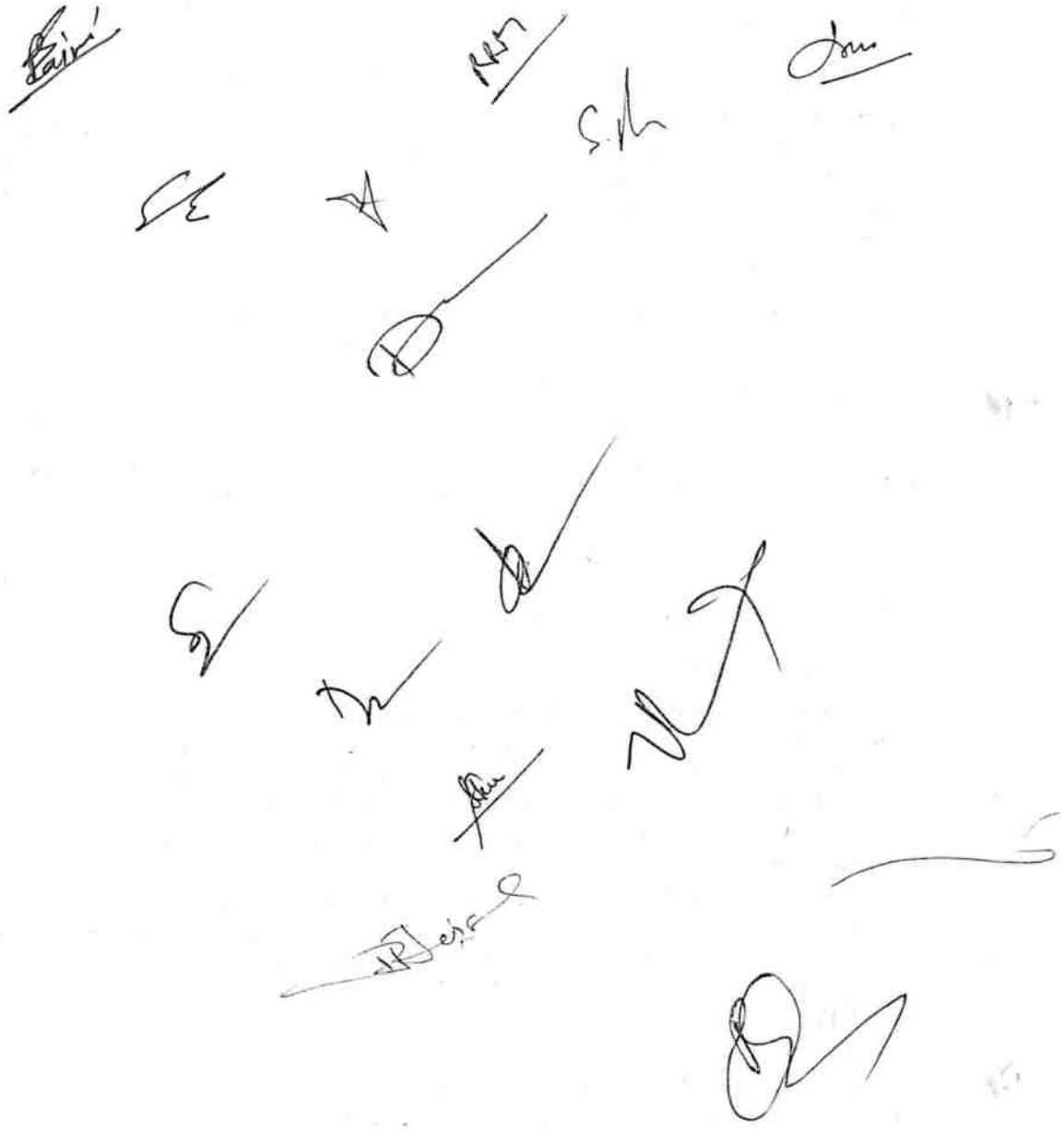
Axisymmetric Problem 9

Introduction,Thick-Walled Cylinder Subjected to Internal and ExternalPressures—Lame's Problem, Stresses in Composite Tubes—Shrink Fits, Sphere with Purely Radial Displacements, Stresses Due to Gravitation, Rotating Disks of Uniform Thickness, Disks of Variable Thickness, Rotating Shafts and Cylinders, Summary of Results for use in Problems

Energy Methods

Work, Strain Energy and Complementary Energy, Castigliano's Theorems-Method of Fictitious Loads and

Statically Indeterminate Problems, Principle of Virtual Work, The Principle of Stationary Potential Energy
Books & References
1. Advanced Mechanics of Materials-by P. Boresi and Richard J. Schmidt (Wiley) 2. Advanced Strength and Applied Stress Analysis by R. G. Budynas, 2nd Edition, McGraw Hill Publishing Co, 1999. 3. Theory of Elasticity, 3rd Edition by S. P. Timoshenko, J. N. Goodier,McGraw Hill Publishing Co. 1970. 4. Solid Mechanics for Engineering by P. Raymond, 1st Edition, John Willey & Sons, 2001. 5. Advanced Mechanics of Solids by L. S. Srinath ((Tata McGraw Hill).)



MECHANICAL ENGINEERING DEPARTMENT
M. M. M. UNIVERSITY OF TECHNOLOGY
GORAKHPUR

Credit Structure of M.Tech. (Energy Technology and Management)

Category Semesters	I	II	III	IV	Total
Maths (M)	5	-	-	-	5
Programme Core (PC)	13	9	-	-	22
Program Electives (PE)	-	8	8	-	16
Minor Project (MP)	-	-	4	-	4
Dissertation (D)			4	14	18
Seminar (S)	-	-	-	2	2
Total	**18**	**17**	**16**	**16**	**67**

Curriculum for M.Tech. (Energy Technology and Management)

Junior Year, Semester-I

S.N.	Category	Paper Code	Subject Name	L	T	P	Credit
1.	M	MAS-101	Numerical Methods &Engineering Optimization	3	1	2	5
2.	PC	MME-201	Advanced Energy Conversion System	3	1	2	5
3.	PC	MME-102	Computational Methods in Engineering	3	1	0	4
4.	PC	MME-204	Clean Energy System	3	1	0	4
5.	AC		Audit subject				
			Total	**12**	**4**	**4**	**18**

Junior Year, Semester-II

S.N.	Category	Paper Code	Subject Name	L	T	P	Credit
1.	PC	MME-203	Advanced Heat Transfer	3	1	2	5
2.	PC	MME-202	Refrigeration and Air Conditioning System Design	3	1	0	4
3.	PE1		Program Elective-1	3	1	0	4
4.	PE2		Program Elective-2	3	1	0	4
5.	AC		Audit subject				
			Total	**12**	**4**	**2**	**17**

Senior Year, Semester-III

S.N.	Category	Paper Code	Subject Name	L	T	P	Credit
1.	PE3		Program Elective-3	3	1	0	4
2.	PE4		Program Elective-4	3	1	0	4

19.5.2018

3.	MP	MME-220	Minor Project	0	0	8	4
4.	D	MME-230	Dissertation Part-I	0	0	8	4
			Total	**6**	**2**	**16**	**16**

Senior Year, Semester-IV

S.N.	Category	Paper Code	Subject Name	L	T	P	Credit
1.	S	MME-240	Seminar	0	0	4	2
2.	D	MME-250	Dissertation Part-II	0	0	28	14
			Total	**0**	**0**	**32**	**16**

Program Core(Energy Technology and Management)

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
1.	MAS-101	Numerical Methods & Engineering Optimization	--	3	1	2	5
2.	MME-102	Computational Methods in Engineering	--	3	1	0	4
3.	MME-201	Advanced Energy Conversion System	--	3	1	2	5
4.	MME-202	Refrigeration and Air Conditioning System Design	--	3	1	0	4
5.	MME-203	Advanced Heat Transfer	--	3	1	2	5
6.	MME-204	Clean Energy System	--	3	1	0	4
7.	MME-220	Minor Project	--	0	0	8	4
8.	MME-230	Dissertation Part-I	--	0	0	8	4
9.	MME-240	Seminar	--	0	0	4	2
10.	MME-250	Dissertation Part-II	Dissertation Part-I	0	0	28	14

Program Electives PE1 & PE2 (Energy Technology and Management) *

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
1.	MME-252	Combustion Engineering	-	3	1	0	4
2.	MME-254	Energy Storage Systems	-	3	1	0	4
3.	**MME-263**	**Nuclear Science and Engineering**	-	3	1	0	4

Program Electives PE3& PE4(Energy Technology and Management) *

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
1.	MME-161	Finite Element Method	-	3	1	0	4
2.	MME-253	Design of Heat Transfer Equipments	-	3	1	0	4
3.	MME-261	Energy Management and Audit	--	3	1	0	4
4.	MME-262	Alternative Fuels for Transportation	-	3	1	0	4
5.	MME-264	Environmental Impact of Energy Systems	-	3	1	0	4

Audit Courses for M.Tech. (Energy Technology and Management)

S.N.	Paper Code	Subject		L	T	P	Credits
		Semester-I					
1.	MAS-105	Applied Probability and Statistics	-	3	1	0	4
2.	BOE-04	Principles of Remote Sensing		2	1	0	3
3.	BOE-07	Introduction to Data and File Structures	-	2	1	2	4
4.	MBA-109	Research Methodology	-	3	1	0	4
		Semester-II					
1.	BAS-27	Discrete Mathematics	-	3	1	0	4
2.	BCE-21	Environmental Impact Assessment & Management	-	3	1	0	4
3.	BCS-73	Neural Network & Fuzzy Systems	-	3	1	0	4
4.	BEE-15	Introduction to Microprocessors	-	3	1	2	5
5.	MBA-106	Human Resource Management	-	3	1	0	4

19.8.2018

* Besides ~~these~~ the Program elective subjects, students may be offered other elective subjects with prior permission of the competent Authority

19/8/18

Department of Mechanical Engineering

Madan Mohan Malaviya University of Technology, Gorakhpur-273 010, India

M. Tech. (Energy Technology & Management) Syllabus

MME-102	**Computational Methods in Engineering**

Course Category	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial : 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one minor test and one major examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge and skills after completing this course

1. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions
2. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
3. Ability to select appropriate numerical methods for various types of problems in engineering.
4. Analyse and evaluate the accuracy of common numerical methods.

Topics Covered	
UNIT-I	
Introduction to Linear Algebraic Equation, Roots of Equation, Numerical differentiation and Integration, Initial and boundary value problems. **Systems of Linear Algebraic Equations:** Gauss Elimination Method, LU Decomposition Methods, Interpolation and Curve Fitting: Polynomial Interpolation, Interpolation with Cubic Spline.	9
UNIT-II	
Roots of Equations: Incremental Search Method, Method of Bisection, Methods Based on Linear Interpolation, Newton–Raphson Method, Systems of Equations	9
UNIT-III	
Numerical Differentiation and Integration: FiniteDifferenceApproximations, RichardsonExtrapolation, DerivativesbyInterpolation, Implicit and explicit integration schemes, **Partial Differential Equations**	9
UNIT-IV	
Initial and Boundary ValueProblems: TaylorSeriesMethod, Runge–KuttaMethods, ShootingMethod.**SymmetricMatrixEigenvalueProblems**.	9

Textbooks	
1.	JaanKiusalaas, Numerical Methods in Engineering with Matlab , Second Edition, Cambridge University Press.

2. Arnold Neumaier, Introduction to Numerical Analysis, , Cambridge University Press.

Reference books

1. Rao. V. Dukkipati ,MATLAB an Introduction with Application, , New Age Publisher

MME-201	**ADVANCED ENERGY CONVERSION SYSTEM**

CourseCategory	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 2
Number of Credits	:	5
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory & Practical Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Ability to apply the concept of Exergy in energy conversion systems.
2. Ability to analyze the different parameters of combined vapour power cycles which affects the overall efficiency of the thermal power plant.
3. Ability to analyze the different operating and design parameters of the air propulsion system.
4. Ability to analyze the performance of energy conversion utility system.

Topics Covered

UNIT-I	
Introduction of energy conversion systems: Energy sources and demand, CO_2 emissions and global temperature, Direct and indirect energy conversion, Energy efficiencies. **Energy and Exergy Analysis:** Reversible work and irreversibility, Exergy change of a closed and open system, Exergy transfer by heat, work and mass, Decrease of exergy principle and exergy destruction, Exergy balance in closed and open system, Energy efficiency based on the second law of thermodynamics.	9
UNIT-II	
Combined Gas and Vapour Power Cycles: Parameter affecting the performance of Rankine cycle, Recapitulation of simple and reheat-regenerative Rankine cycle, Supercritical Rankine cycle, Binary vapour power cycle, Organic Rankine cycle, Parameter affecting the performance of Brayton cycle, Recapitulation of simple and reheat-regenerative-intercooled Brayton cycle, Co-generation and Tri-generation, Combined gas and vapour power cycle, Second law analysis of combined cycles.	9
UNIT-III	
Gas Turbine and Air Propulsion: Introduction of gas turbine engines, Thrust equations, propulsive efficiency, Components of gas turbine engines, Parametric cycle analysis of ideal engine. Turbojet, Turboprop, Turbofan, Ram jet and Scram jets engine.	9
UNIT-IV	
Energy Conversion Utility Systems: Review of low pressure and high pressure boilers, supercritical boiler, FBC Boiler, performance evaluation of boiler, theory of steam and gas nozzles, steam turbine, compounding of steam turbine, Impulse steam turbine and its performance, Impulse reaction steam turbine and its performance, energy losses in steam turbine, condensers and its thermodynamic analysis.	9

EXPERIMENTS

Minimum Eight experiments are to be performed

1. Study and analysis of modern high pressure Boilers.
2. Experiment on condenser.
3. Experiment on MPFI four stroke multi cylinder petrol engine.
4. Experiment on CRDI four stroke multi cylinder diesel engine.
5. Experiment on axial flow compressor.
6. Experiment on Hydraulic Turbines.
7. Experiment on Sterling Engine.
8. Experiment on cooling tower and their performance characteristics.
9. Experiment on exhaust gas analyser.

Textbooks	
	APPLIED Thermodynamics by P. K. Nag, TMH Edition.
	Thermodynamics and Heat power (8th Edition): Irving Granet, Maurice Bluestein, CRC Press Taylor & Francis Group.
	Principles of Energy Conversion: A.W.Culp(McGrawHill International)
	Thermodynamics: An engineering approach (8th Edition), Tata McGraw Hill.
	Advanced Engineering Thermodynamics (2nd Edition), John Wileys& Sons, Inc.
Reference books	
	Aircraft Propulsion and Gas Turbine Engines, Second Edition:Ahmed F. El-Sayed, CRC Press Taylor & Francis Group.
	Energy Conversion Principles:Begamudre,Rakoshdas
	Applied Thermodynamics: Availability and Energy Conversion Method: Kam W. Li, CRC Press Taylor & Francis Group.
	Combined Cycles and Steam Turbine Power Plant: Rolf Keh and FrenkHennemann, PennWell Books; 3rd Edition.
	Boilers for Power and Process: Kumar Rayaprolu, CRC Press Taylor & Francis Group.
	Thermal power Plant Design & operation: Dipak Sarkar, Elsevier; 1 edition

MME-202		**REFRIGERATION & AIR CONDITIONING SYSTEM DESIGN**
Course Category	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 2
Number of Credits	:	5
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, class tests and One Minor test and One Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Understand the basics of refrigeration, different refrigeration cycles and different types of refrigeration systems.
2. Understand the properties of refrigerants, its impact on environment and designing of different components of refrigeration and air conditioning system.

3. Basics and design calculations of air conditioning systems. 4. Knowledge of different types of non-conventional refrigeration systems.	
Topics Covered	
UNIT-I	
Recapitulation of basic refrigeration: Reversed Carnot cycle, Joule cycle, Simple vapour compression systems, Multistage vapour compression system, Multi evaporator refrigeration systems, Cascade systems, Vapourabsorbtion refrigeration systems, Ejector compression system	9
UNIT-II	
Refrigerants: Classification of Refrigerants, Refrigerant properties, ODP and GWP, Environmental Impact-Montreal/ Kyoto protocols-Eco Friendly Refrigerants **Design of components of refrigeration and air conditioning system:** Design of compressors, Design of expansion devices, Duct design	9
UNIT-III	
Air Conditioning: Properties of moist air, Psychrometry of Air Conditioning processes, Design conditions of air conditioning, Heat transfer through building structure, Heating and cooling load calculations	9
UNIT-IV	
Non-Conventional Refrigeration Systems: Thermoelectric Refrigeration, Vortex tube refrigeration, Pulse tube refrigeration, Cooling by adiabatic demagnetization, Solar refrigeration and air conditioning systems	9
EXPERIMENTS Minimum Eight experiments are to be performed 1. Experiment on refrigeration test rig and calculation of various performance parameters. 2. Experiment on vapour absorption refrigeration test rig. 3. To study different types of expansion devices used in refrigeration system. 4. To Study window air conditioner. 5. Experiment on Ice-plant. 6. Experiment on air-conditioning test rig & calculation of various performance parameters. 7. Experiment on Vortex tube test rig. 8. To study air washers and determine efficiency of air washer. 9. Visit of a central air conditioning plant and its detailed study. 10. Visit of cold-storage and its detailed study.	

Textbooks	
1.	Refrigeration and Air Conditioning: Manohar Prasad, New Age publication
2.	Refrigeration and Air Conditioning: C.P. Arora, Mc-Graw hill publication
3.	Principles of Refrigeration: Roy. J Dossat, Pearson publication
Reference books	
1.	Refrigeration and Air Conditioning:W.F. Stocker and J. W. Jones, Mc-Graw hill Inc. publication
2.	Refrigeration and Air Conditioning: G.F. Hundy, A.R. Trott and T.C. Welch (Auth.) -Elsevier, Butterworth-Heinemann (2008)
3.	Handbook of Air Conditioning and Refrigeration: Shan K. Wang-, Mc-Graw hill Inc. publication
4.	Solar Air Conditioning and Refrigeration: A.A.M. SAYIGH and J.C. MCVEIGH, PERGAMON Press

18.8.2018

MME-203	ADVANCED HEAT TRANSFER	
Course Category	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 2
Number of Credits	:	5
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory and Practical Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Student will be able to calculate the temperature profile and rate of heat transfer in 1D system with variable thermal conductivity and heat generation and also the study of various fin profiles.
2. Student will be able to make calculations for temperature and rate of heat transfer in steady state and unsteady state 2D systems using Groeber's and Heisler charts.
3. Ability to understand the basics of radiation and its various models of successive reflection and also radiation through absorbing media.
4. Ability to understand and calculate velocity and temperature profile and rate of heat transfer by convection over a flat plate and tubes.

Topics Covered

UNIT-I	
Review: Reviews of basic laws of Conduction, Convection and Radiation **Conduction:** One-dimensional steady state conduction with variable thermal conductivity and with internaldistributed heat source and moving heat source problem, Local heat source in non-adiabatic plate, Thermocouple conduction error, Extended Surfaces-Review, Optimum fin of rectangular profile, straight fins of triangular and parabolic profiles, Optimumprofile, Circumferential fin of rectangular profile, spines, design considerations.	9
UNIT-II	
2D steady state heat conduction, semi -infinite and finite flat plates, Temperature fields in finite cylinders and ininfinite semi-cylinders, spherical shells, Graphical method, relaxation technique, Unsteady state conduction,Sudden changes in the surface temperatures of infinite plates, cylinders and spheres using Groeber's and Heislercharts for plates, cylinders and spheres suddenly immersed in fluids.	9
UNIT-III	
Radiation: Review of radiation principles, Diffuse surfaces and the Lambert's cosine law. Radiation through nonabsorbingmedia, Hottel's method of successive reflections, Gebhart's unified method, Poljak's method. Radiationthrough absorbing media, Logarithmic decrement of radiation, Apparent absorptive of simple shaped gas bodies,Net heat exchange between surfaces separated by absorbing medium, Radiation of luminous gas flames.	9
UNIT-IV	
Convection: Heat transfer in laminar flow, free convection between parallel plates, forced internal flow throughcircular tubes, fully developed flow, Velocity and thermal entry length, solutions with constant wall temperatureand with constant heat flux, Forced external flow over a flat plate, two-dimensional velocity and temperatureboundary layer equations, Karman Pohlhousen approximate integral method. Heat transfer in turbulent	9

flow, Eddy heat diffusivity, Reynold's analogy between skin friction and heat transfer, Prandtl-Taylor, Von Karman andMartineli's analogies, Turbulent flow through circular tubes.	

EXPERIMENTS

Minimum Eight experiments are to be performed

1. Experiment on Conduction - Composite wall experiment
2. Experiment on Conduction - Composite cylinder experiment
3. Experiment on Convection - Pool Boiling experiment
4. Experiment on Convection - Experiment on heat transfer from tube-natural convection.
5. Experiment on Convection - Heat Pipe experiment.
6. Experiment on Convection - Heat transfer through fin-natural convection.
7. Experiment on Convection - Heat transfer through tube/fin-forced convection.
8. Experiment on Any experiment on Stefan's Law, on radiation determination of emissivity, etc.
9. Experiment on Any experiment on solar collector, etc.
10. Experiment on Heat exchanger - Parallel flow experiment
11. Experiment on Heat exchanger - Counter flow experiment
12. Experiment on Any other suitable experiment on critical insulation thickness.
13. Experiment on Conduction - Determination of thermal conductivity of fluids.
14. Experiment on Conduction - Thermal Contact Resistance Effect.

Textbooks

1.	Advances in Heat Transfer- James P Hartnett (Academic Press)
2.	Principles of Heat Transfer- Kaviany M (Wiley-International)
3.	Heat Transfer: Principles and Applications-B.K. Datta (Prentice Hall of India)

Reference books

1.	Heat Transfer Calculations- Myer Kutz (McGraw-Hill)
2.	Convective Heat Transfer- Burmeister Louis (Wiley-International)

MME-204		**CLEAN ENERGY SYSTEMS**
Course Category	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and One Minor test and One Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Ability to understand basics of solar energy, solar time calculations and production and utilization of biomass in different areas.
2. Student will be able to understand basics of wind energy, power calculations, site selection and wind power production plants.
3. Ability to understand the principle, construction and application of fuel cell and also about power production and distribution by hydel energy.
4. Ability to apply the concept of material and energy balance by various methods and flow charts.
5. Ability to understand the methods and tools of energy audit along with maximizing the energy efficiency.

19.8.2011

Topics Covered	
UNIT-I	
Solar Energy: Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment: Various Methods of using solar energy –Photothermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy **Bio-mass energy:** Biomass: Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Biochemical and Thermo-Chemical Conversion, Combustion, Gasification, Biomass gasifiers and types etc., Applications of Gasifiers to thermal power and Engines, Biomass as a decentralized power generation source for villages.	9
UNIT-II	
Wind Energy: Wind Energy: Basics & Power Analysis, Wind resource assessment, Power Conversion Technologies and applications, Wind Power estimation techniques, Principles of Aerodynamics of wind turbine blade, Various aspects of wind turbine design, Wind Turbine Generators: Induction, Synchronous machine, constant V & F and variable V & F generations, Reactive power compensation. Site Selection, Concept of wind form & project cycle, Cost economics	9
UNIT-III	
Fuel Cell: Fuel cell – Principle of working, construction and applications **Material and Energy Balance:** Basic Principles; The Sankey Diagram and its Use; Material Balances; Energy Balances; Method for Preparing Process Flow Chart; Facility as an Energy System; How to Carryout Material and Energy (M & E) Balance.	9
UNIT-IV	
Energy Audit: Energy Audit: Types and Methodology; Energy Audit Reporting Format; Understanding Energy Costs; Benchmarking and Energy Performance; Matching Energy Usage to Requirement; Maximizing System Efficiency; Fuel and Energy Substitution; Energy Audit Instruments; Duties and responsibilities of energy auditors.	9

Textbooks	
1.	Principles of Thermal Process: Duffie -Beckman.
2.	Solar Energy Handbook: Kreith and Kreider (McGraw Hill)
3.	Biomass Renegerable Energy – D.O.hall and R.P. Overeed
4.	Energy Management: W.R.Murphy, G.Mckay (Butterworths)
Reference books	
1.	Renewable Sources of Energy and Conversion Systems: N.K. Bansal and M.K. Kleeman
2.	Wind energy Conversion Systems – Freris L.L. (Prentice Hall1990)
3.	Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)

MME-220	**MINOR PROJECT**	
CourseCategory	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 0, Tutorial: 0, Practical: 8
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through attendance, project reports, mid semester presentation and end semester presentation.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understanding of importance of literature survey.
2. Develop ability to comprehend the research paper.
3. Understanding of steps involved in writing the research paper.
4. Develop the ability to write a research paper.

MME-230	DISSERTATION PART-I	
Course Category	:	Program Core (PC)
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	Lecture: 0, Tutorial: 0, Practical: 8
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through attendance, project reports, mid semester presentation and end semester presentation.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Analyze and apply prior knowledge to designing and implementing solutions to open-ended computational problems while considering multiple realistic constraints.
2. Analyze the selected topic, organize the content and communicate to audience in an effective manner
3. Application of various thermal engineering concepts and analyze Database.
4. Evaluate the various validation and verification methods

MME-240	SEMINAR	
CourseCategory	:	Program Core (PC)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 0, Tutorial: 0, Practical: 4
Number of Credits	:	2
Course Assessment Methods	:	Continuous assessment through presentations and viva voce
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to understand the working in real environment and get acquainted with the organization structure, business operations and administrative functions.
2. They able to enhance the communications and presentation skills.
3. Ability to evaluate, credit, and synthesize sources.
5. Understanding to write technical documents and give oral presentations related to the work completed.

19.8.2016

MME-250	DISSERTATION PART-II	
Course category	:	Program Core (PC)
Pre-requisite Subject	:	Dissertation Part-I
Contact hours/week	:	Lecture : 0, Tutorial : 0, Practical: 28
Number of Credits	:	14
Course Assessment methods	:	Continuous assessment through attendance, project reports, mid semester presentation and end semester presentation.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course
1. Synthesizing and applying prior knowledge to designing and implementing solutions to open-ended computational problems while considering multiple realistic constraints. 2. Analyze the selected topic, organize the content and communicate to audience in an effective manner 5. Application of various thermal engineering concepts and analyze Database. 3. Evaluate the various validation and verification methods 4. Analyzing professional issues, including ethical, legal and security issues, related to computing projects		

MME-251	ECONOMICS AND PLANNING OF ENERGY SYSTEMS	
Course Category	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.
1. Ability to understand the evaluation of energy technology and economics of energy conservation. 2. Ability to understand Energy demand, Energy models and energy planning. 3. Ability to understand implications of energy, clean development mechanism, energy transfer with financing. 4. Ability to understand the carbon credits, trading opportunities and energy policy acts with regulations.		
Topics Covered		
UNIT-I		
Relevance of financial and economic feasibility, Evaluation of energy technologies and systems, Basics		9

ofengineering economics, Financial evaluation of energy technologies, Social cost benefit analysis, Case studies ontechno-economics of energy conservation and renewable energy technologies.	
UNIT-II	
Energy demand analysis and forecasting, Energy supply assessment and evaluation, Energy demand – supplybalancing, Energy models, Software for energy planning,	9
UNIT-III	
Energy – economy interaction, Energy investment planning and project formulation. Energy pricing, Policy andplanning implications of energy – environment interaction, clean development mechanism, technology transferand its financing	9
UNIT-IV	
Carbon credits and trading opportunities, Financing of energy systems, Energy policy related acts and regulations	9
Textbooks	
1. Economic Issues of Renewable Energy Systems Gerhard Oelert, Falk Aner& Klaus Pertz	
Reference books	
1. Energy Policy: B. G. Desai	

MME-252	**COMBUSTION ENGINEERING**	
CourseCategory	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.
1. Ability to understand the basics, importance and thermodynamics behind combustion. 2. Ability to understand kinetics of combustion and various aspects pertaining to propagation of flame. 3. Ability to understand advances of burning of fuel in spray form and also about the ignition. 4. Student will be able to tell combustion generated pollution and their controls.		
Topics Covered		
UNIT-I		
Introduction: Importance of combustion; Combustion equipment's, Hostile fire problems, pollution problemsarising from combustion. **Thermodynamics of Combustion:** Enthalpy of formation; Enthalpy of reaction; Heating values; First & second laws; Analysis of reaction system, Chemical equilibrium, Equilibrium composition; Adiabatic &equilibrium,Flame temperature.		9
UNIT-II		

19.8.2011

Kinetics of Combustion: Law of mass action; Reacting rate; Simple and complex reaction; Reaction order &molecularity, Arhenius laws; Activation Energy; Chain reaction; Steady rate & Partial equilibrium approximation;chain explosion; Explosion limit and oxidation characteristics of hydrogen, Carbon monoxide, Hydrocarbons. . **Flames:** Remixed flame structure & propagation of flames in homogeneous mixtures; Simplified RankineHugoniot relation, Properties of Hugoniot curve, analysis of Deflagration & detonation branches, Properties of Chapmen Jouguetwave, Laminar flame structure; Theories of flame propagation & calculation of flame speedmeasurements. Stability limits of laminar flames; Flammability limits & quenching distant, Burner design, Mechanism of flamestablization in laminar &turbulent flows, Flame quenching, Diffusion flames; Comparison of diffusion withpremixed flame, combustion of gaseous fuel, jets burke & Schumann development.	9
UNIT-III	
Burning of Condensed Phase: General mass burning considerations, Combustion of fuels droplet in a quiescent and convective environment, Introduction to combustion of fuel sprays **Ignition:** Concept of ignition, Chain ignition, Thermal spontaneous ignition, Forced ignition.	9
UNIT-IV	
Combustion Generated Pollution & its Control: Introduction, Nitrogen oxide, Thermal fixation of atmosphericnitrogen prompts, NO, Thermal NOx & control in combustors. Fuel NOx & control, post combustion destructionof NOx, Nitrogen dioxide, carbon monoxide Oxidation-Quenching, Hydrocarbons, Sulphur oxide.	9

Textbooks	
1.	Internal Combustion Engines: Applied Thermo sciences- Ferguson Colin R (John Wiley)
2.	Engineering Fundamentals of the Internal Combustion Engine- Pulkrabek (Pearson Education)
Reference books	
1.	Instrumentation for Combustion and Flow in Engines- Durao D F G (Kluwer Aca)
2.	Energy from Biomass: A Review of Combustion and Gasification Technologies - Quaak Peter

MME-253	**DESIGN OF HEAT TRANSFER EQUIPMENTS**	
CourseCategory	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and One Minor tests and One Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Student will be able to design co-current, counter current and cross flow heat exchangers.
2. Student will be able to design hair-pin heat exchangers and their calculations.
3. Student will be able to design shell and tube heat exchangers and boiling curve & condensation mechanisms.
4. Student will be able to design the cooling tower and evaporators in various applications.

Topics Covered	
UNIT-I	
Introduction to Heat exchangers: Definition, TEMA classification of heat exchangers and their applications, concept of varying overall heat transfer coefficient. **Analysis of heat exchangers:** LMTD analysis of single pass co-current, counter-current and cross flow heat	9

exchangers, special operating conditions, influence of fouling factor, contrast between LMTD and AMTD, effectiveness-NTU method, charts solutions for heat exchangers, pressure drop calculation in heat exchanger.	
UNIT-II	
Compact and plate heat exchangers: Types, merits and demerits, design of compact heat exchangers, performance influencing parameters, limitations. **Hair-pin Heat Exchangers-** Introduction to counter flow double pipe or hair-pin heat exchangers, Augmentation of hair-pin heat exchangers, film coefficient in tubes and annulus, pressure drop calculation, Algorithm for design and performance calculation of hair-pin heat exchangers.	9
UNIT-III	
Shell and tube heat exchangers: Classification and nomenclature pertaining to industrial version heat exchangers, baffles and tube-pitch arrangement, thermal design consideration of shell and tube heat exchanger for single and two-phase heat transfer, calculations. **Boiling and condensation:** Pool boiling, forced convection boiling, physical mechanism of condensation, laminar film and turbulent film condensation, condensation in horizontal tube, drop wise condensation.	9
UNIT-IV	
Cooling towers: Basic principle of evaporative cooling, psychrometric processes, classification of cooling towers, performance characteristics of cooling tower. **Evaporators:** Introduction and classifications of evaporator, temperature profile in evaporator, methods of feeding evaporator, performance of evaporator, thermal design considerations, mechanical design considerations, single effect and multiple effect evaporator.	9

Textbooks	
1.	Heat Exchangers Selection Rating and Thermal Design (2nd Edition): SadikkakacHongtan Liu, **CRC** Press Boca Rattan Londan New York, Washington, D.C.
2.	Heat Exchanger Design: Ramesh K. Shah and Dusan P. Sekulic, John Wiley & Sons, Inc.
3.	Incropera, F. P. and De Witt, D. P., Fundamentals of Heat and Mass Transfer, 4th Edition, John Wiley and Sons, New York.
Reference books	
1.	Donald Q. Kern: Process Heat Transfer, **McGraw – Hill,** New York.
2.	Kays, W. M. and London, A. L., Compact Heat Exchangers, 2nd Edition, **McGraw – Hill**, New York.
3.	Process Heat Transfer principles and Applications, R.W. Serth, **Academic Press is an imprint of Elsevier**

MME-254		**ENERGY STORAGE SYSTEM**
CourseCategory	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory Examination.

Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Understand need and potential of energy storage system.
2. 4Understand the concept electrochemical energy storage and sensible heat storage system.
3. Understand the concept of phase change material and numerical analysis of heat transfer mechanism of PCM during melting and freezing process.
4. Understanding about the application of energy storage system in the field of solar energy, waste heat, drawing and heating for process industries.

Topics Covered	
UNIT-I	
Need of energy storage; Different modes of Energy Storage Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels, Hydrogen for energy storage. Solar Ponds for energy storage	9
UNIT-II	
Electrochemical Energy Storage Systems: Batteries: Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon nano-tubes in electrodes Sensible Heat Storage SHS mediums; Stratified storage systems; Rock-bed storage systems; Thermal storage in buildings; Earth storage; Energy storage in aquifers; Heat storage in SHS systems; Aquifers storage.	9
UNIT-III	
Latent Heat Thermal Energy Storage: Phase Change Materials (PCMs); Selection criteria of PCMs; Stefan problem; Solar thermal LHTES systems; Energy conservation through LHTES systems; LHTES systems in refrigeration and air-conditioning systems; Enthalpy formulation; Numerical heat transfer in melting and freezing process	9
UNIT-IV	
Some Areas of Application of Energy Storage: Food preservation; Waste heat recovery; Solar energy storage; Greenhouse heating; Power plant applications; Drying and heating for process industries.	9

Textbooks	
1.	Energy storage Robert Huggins Springer
Reference books	
1.	Solar Energy Handbook: Kreith and Kreider (McGraw Hill)

MME-255	**HYDROGEN ENERGY**	
CourseCategory	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0

Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Ability to understand the basics of hydrogen energy such as- requirements, storage, utilization etc. and various methods of hydrogen generation.
2. Ability to understand the physical & chemical properties of hydrogen and various methods of storage of hydrogen.
3. Ability to apply the concept of hydrogen utilization in various applications such as- IC engines, gas turbines, power plants etc. and its various characteristics related to performance and emission in SI engines.
4. Ability to understand the various safety issues for using hydrogen energy and risk analysis along with simulation of crash tests.

Topics Covered

UNIT-I	
Hydrogen pathways introduction – current uses, General introduction to infrastructure requirement for hydrogen production, storage, dispensing and utilization, and hydrogen product ion power plants. Thermal-Steam Reformation – Thermo Chemical Water Splitting – Gasification – Pyrolysis, Nuclear thermo catalytic and partial oxidation methods. Electrochemical – Electrolysis – Photo electro chemical, Biological – Photo Biological – Anaerobic Digestion Fermentative Micro- organisms	9
UNIT-II	
Physics and chemical properties – General storage methods, compressed storage – composites cylinders – Glass micro sphere storage – Zeolities, Metal hydride storage, chemical hydride storage and cryogenic storage.	9
UNIT-III	
Overview of hydrogen utilization: I.C. Engines, gas turbines, hydrogen burners, power plant, refineries, domestic and marine applications. Hydrogen fuel quality, performance, COV, emission and combustion characteristics of Spark Ignition engines for hydrogen, back firing, knocking, volumetric efficiency, hydrogen manifold and direct injection, fumigation, NOx controlling techniques, dual fuel engine, durability studies, field trials, emission and climate change.	9
UNIT-IV	
Safety barrier diagram, risk analysis, safety in handling and refueling station, safety in vehicular and stationary applications, fire detecting system, safety management, and simulation of crash tests.	9

Textbooks

1.	Fuel Cells and Hydrogen Energy Bansal, Narottam P.

Reference books

1.	Industrial Hydrogen Hugh S. Taylor D.Sc
2.	Hydrogen Generator Gas for Vehicles and Engines John D Cash; Martain Cash

19.8.2018

MME-161	FINITE ELEMENT METHOD	
Course category	:	Program Electives (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial : 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voice, one major test and one major examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To develop the ability to generate the governing finite element equations for systems governed by partial differential equations.
2. To understand the use of the basic finite elements for structural applications using truss, beam, frame and plane elements;
3. To understand the application and use of the finite element method for heat transfer problems.
4. To demonstrate the ability to evaluate and interpret Finite Element Method analysis results for design and evaluation purposes.
5. To develop a basic understanding of the limitations of the Finite Element Method and understand the possible error sources in its use.

Topics Covered

UNIT-I	
Introduction: Historical background,basic concepts of FEM, Comparison with Finite Difference Method, Advantages and limitations, Different approaches in Finite Element Method-Discrete, Variational approach, Weighted Residual methods.	9
UNIT-II	
Direct Problems- Spring, Hydraulic Network; Resistance Network and Truss Systems **Finite element analysis of 1-D problems:** formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its postprocessing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame.	9
UNIT-III	
Finite element analysis of 2-D problems: Finite Element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics;	9
UNIT-IV	
Numerical considerations: numerical integration, error analysis, mesh refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems; Discussion about preprocessors, postprocessors and finite element packages.	9

Books & References

1. An Introduction to Finite Element Method – J. N. Reddy (Tata McGraw Hill).
2. Finite Element Procedure in Engineering Analysis - K.J. Bathe (Tata McGraw Hill). (New Central book Agency)
3. Concepts and Application of Finite Element Analysis- R.D. Cook, D.S. Malcus and M.E. Plesha (John Wiley)
4. Introduction to Finite Elements in Engineering- T.R Chandrupatla and A.D. Belegundu (Prentice Hall India)
5. Numerical Methods– E. Balagurswamy (Tata Mc Graw Hill)

MME-261	ENERGY MODELLING AND PROJECT MANAGEMENT	
CourseCategory	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Understand the importance of energy management and application of energy management in boiler, turbine and heat exchanger etc.
2. Understand the concept of energy audit and responsibility of energy auditor.
3. Knowledge of material and energy balance of energy converting devices
4. Understand the purpose energy policies, managerial function, strategies, marketing, training and planning of any organization

Topics Covered

UNIT-I	
Models and modeling approaches: Input output analysis, energy demand analysis and forecasting, project management. Multiplier Analysis – Energy and Environmental Input / Output Analysis-Energy Aggregation-Econometric Energy Demand Modeling-Overview of Econometric Methods. Methodology for Energy Demand Analysis – Methodology for Energy Technology Forecasting-Methodology for Energy Forecasting Sectoral Energy Demand Forecasting. Solar Energy-Biomass Energy-Wind Energy and other Renewable Sources of Energy.	9
UNIT-II	
Basic concept of econometrics and statistical analysis: The 2-variable regression model; The multiple regression model; Tests of regression coefficients and regression equation; Econometric techniques used for energy analysis and forecasting with case studies from India; Operation of computer package Input – Output Analysis, Basic concept of Input-output analysis; concept of energy multiplier and implication of energy multiplier for analysis of regional and national energy policy; Energy and environmental Input – Output analyses using I-O model.	9
UNIT-III	
Energy Modeling: **Interdependence of energy-economy- environment;** Modeling concept, and application, Methodology of energy demand analysis; Methodology for energy forecasting; Sectoral energy demand forecasting; Interfuel substitution models; SIMA model, and I-O model for energy policy analysis; Simulation and forecasting of future energy demand consistent with macroeconomic parameters in India; Energy Economics and Policies: National and Sectoral energy planning; Integrated resources planning; Energy pricing.	9
UNIT-IV	

14.8.2018

Project Evaluation & Management: Financial analysis: Project cash flows, time value of money, life cycle approach & analysis, conception, definition, planning, feasibility and analysis; Project appraisal criteria; Risk analysis; Project planning matrix; Aims oriented project planning; Social cost benefit analysis. Network analysis for project management; Time estimation; Critical path determination; PERT, CPM and CERT: Fuzzy logic analysis; Stochastic based formulations; Project evaluation techniques; Funds planning; Project material management, evaluation & analysis; Implementation and monitoring; Performance indices; Case studies. Autonomous Fossil Fuel and renewable energy (RE) - based Power Systems.	9
Textbooks	
Energy Policy Analysis and Modeling M. Munasinghe and P. Meier Cambridge University Press,	
The Economics of Energy Demand: A Survey of Applications, W.A Donnelly	
Econometrics Models and Economic Forecasts S. Pindyck and Daniel L Rubinfeld, McGraw Hill, New York 1991	
Reference books	
Forecasting Methods and Applications S.Makridakis Wiley, 1983	
Sectoral Energy Demand Studies: Application of the END-USE Approach to Asian Countries, - UN-ESCAP, New York 1991	

MME-162	**ADVANCES IN MATERIAL SCIENCE AND APPLICATIONS**	
Course Category	:	Program Electives(PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Ability to understand the role of computer in the areas of automation, planning and manufacturing for improving their effectiveness.
2. Ability to develop manual part program and computer assisted part program to produce components.
3. Ability to design and develop various system such as feedback, interpolator, material handling and implementation of adaptive control.
4. Ability to apply the concept of group technology and computer assisted process planning.

Topics Covered	
UNIT-I	
Materials and Classification: Introduction, Demand of advanced materials,Classification of different materials and alloys. Macro and micro analysis of materials, Segregation and bonding, Strengthening mechanisms.	9
UNIT-II	
Properties of Materials: Flexural Test,Toughness tests, Creep characteristics, Hardness tests, Fracture test, Griffith's crack theory, Strain hardening, Single crystal growth. **Wear:** Modes of adhesive, abrasive, erosive, fretting, sliding.	9
UNIT-III	
Techniques of Materials Characterization: Definition; importance and application of X-ray diffraction technique for phase identification.Scanning Electron Microscope; Principles of image formation in SEM, Energy dispersive X-ray analysis, Thermo-mechanical behavior of composites materials, DSC, AFM.	9

UNIT-IV	
Modern Materials and Alloys: Super alloys-refractory materials, Shape memory alloys, Advanced Composites-Particulate and dispersion composites, Metal matrix and Ceramic matrix composites, Nano materials, Polymers and polymerization, Engineering applications of different materials.	9

Textbooks	
1.	Engineering Materials and Applications, P. Flinn and P.K. Trojan, MIR Publications
2.	Engineering Materials: Polymers, Ceramics and Composites, A.K Bhargava, Prentice Hall of India
3.	Manufacturing processes for Engineering Materials, SeropeKalpakjian, Wesley Publishing Co.
4.	An introduction to Physical Metallurgy, S.H. Avner, McGraw Hill
5.	Advances in Materials and Their Applications, P. Rama Rao, Wiley Eastern
6.	Mechanical Metallurgy, Dieter, McGraw Hill
7.	Material Science & Engineering, W.D. Callister, Jr, Wesley Publishing Co.
Reference books	
1.	Mechanical Metallurgy, Dieter, McGraw Hill
2.	Material Science & Engineering, W.D. Callister, Jr, Wesley Publishing Co.

MME-262	**ALTERNATIVE FUELS FOR TRANSPORTATION**	
Course Category	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and Three Minor tests and One Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Ability to understand the basics and need of alternate fuels in current scenario.
2. Ability to utilize the alcoholic fuels and their blends in place of conventional fuels and their performance.
3. Ability to utilize Natural Gas, LPG, Hydrogen and Biogas in SI and CI engines and their performance and emission characteristics.
4. Ability to have knowledge of vegetable oils and their performance and basics of Electric, Hybrid, Fuel Cell and Solar Cars.

Topics Covered

UNIT-I	
Need for alternate fuel Availability and properties of alternate fuels, general use of alcohols, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, merits and demerits of various alternate fuels, introduction to alternate energy sources like EV, hybrid, fuel cell and solar cars.	9
UNIT-II	
Alcohols Properties as engine fuel, alcohols and gasoline blends, performance in SI engine, methanol and gasoline blends, combustion characteristics in CI engines, emission characteristics, DME, DEE properties performance analysis,	9

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performance in SI & CI Engines.	
UNIT-III	
Natural Gas, LPG, Hydrogen and Biogas Availability of CNG, properties, modification required to use in engines, performance and emission characteristics of CNG using LPG in SI & CI engines, performance and emission of LPG. hydrogen; storage and handling, performance and safety aspects hydrogen combustion characteristics, flashback control techniques, safety aspects and system development, NOx emission control, natural gas components, mixtures and kits, fuel supply system and emission studies and control.	9
UNIT-IV	
Vegetable Oils Various vegetable oils for engines, esterification, performance in engines, performance and emission characteristics, bio diesel and its characteristics. **Electric, Hybrid, Fuel Cell and Solar Cars** Layout of an electric vehicle, advantage and limitations, specifications, system components, electronic control system, high energy and power density batteries, hybrid vehicle, fuel cell vehicles, solar powered vehicles.	9

Textbooks	
1.	Alternate Fuels: Emissions, Economics, and performance by Maxwell, Timothy. T, and JessecoJones,Publisher: Society of Automotive Engineers, 1995
2.	Hydrogen fuel for surface transportation by Norbeck, Joseph M., Publisher: Society of AutomotiveEngineers, 1996 3. History of the Electric Automobiles
3.	Alternate Fuels Guide Book by Richard L. Bechhold P.E. Publisher: Society of Automotive Engineers, 1997
Reference books	
1.	History of the Electric Automobiles: Hybrid Electric Vehicles by Wakefield, Earnest Henry
2.	Engine Emissions: Pollutant formation and advances in control Technology by NorbePundir B.R. Publisher:Narosa Publishing House

MME-263		**NUCLEAR SCIENCE AND ENGINEERING**
CourseCategory	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to understand the concept of nuclear physics, Laws of radioactive decay and nuclear models
2. Ability to develop and design blade and understand the performance of horizontal and vertical axis wind machines.
3. Ability to understand Nuclear reactions, nuclear fission and liquid drop model.
4. Ability to control and understand the working of different nuclear reactor.

Topics Covered

UNIT-I	
Nuclear constituents – charge, mass, shape, and size of nucleus, Binding energy, packing fraction, nuclear magnetic moment, saturation and short range nuclear forces, Radioactivity – Laws of radioactive decay, half-life, mean life, specific activity, Nuclear models – single particle shell model, evidence and limitations of shell model, liquid drop model: Introduction, assumptions, semi-empirical mass formula	9
UNIT-II	
Mechanisms of Nuclear Decay Law of radioactive decay, half-life, mean life, specific activity, partial radioactive decay, successive disintegration, α decay: Barrier penetration, β decay: Fermi theory, selection rules, parity non-conservation, γ decay of excited states. **Nuclear Detectors and Accelerators** Types of detectors, Geiger-Mueller counter, Scintillation counter, classification of accelerators, Cyclotron, Betatron.	9
UNIT-III	
Introduction to Nuclear Engineering Theories of Nuclear reactions, Conservation laws, Q-value equation, Nuclear fission, explanation on the basis of liquid drop model, energy available from fission, Nuclear chain reaction, Nuclear fusion.	9
UNIT-IV	
Nuclear Reactors Nuclear Reactor – Basic principle, classification, constituent parts, Heterogeneous reactor, Swimming pool reactor, Breeder reactor, Heavy water cooled and moderated CANDU type reactors, Gas cooled reactors	9

Books & References:

Textbooks

1. D.C. Tayal, Nuclear Physics, Himalayan Publication house, Bombay, 1980.
2. Irving Kaplan, "Nuclear Physics", Narosa Book Distributors, 2002.

Reference books

1. Wind Energy -Sathyajith& Mathew
2. J.H.Horlock ,"Combined Power Plants", Pergamon Press, 1992.
3. R.D. Evans, "The Atomic Nucleus", McGraw-Hill, 1955.

MME-265	**ENVIRONMENTAL IMPACT OF ENERGY SYSTEMS**	
CourseCategory	:	Program Elective (PE)
Pre-requisites	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial: 1, , Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, record, viva voce and Three Minor tests and One Major Theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Understand need and potential of energy storage system.
2. Understand the concept electrochemical energy storage and sensible heat storage system.
3. Understand the concept of phase change material and numerical analysis of heat transfer mechanism of PCM during melting and freezing process.

9.9.20

4. Understanding about the application of energy storage system in the field of solar energy, waste heat, drawing and heating for process industries.	
Topics Covered	
UNIT-I	
Impact of Energy Systems on Environment Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SOx, NOx, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Sociological and Economical problems due to Thermal and other energy projects. Physiological, ecological and environmental and health problems due to energy plants, Methods of Environmental Impact Assessment, Pollution due to Vehicles and Utilities, Methods to control emission from vehicle, Boilers, Furnaces etc., International Standards for quality of air and norms for exhaust gases, Effect of Hydroelectric power stations on ecology and environment	9
UNIT-II	
Pollution due toThermal, Hydel and Nuclear Power Plants Potential sources of pollution in thermal power plant, Air, water, land pollution due to estimation for thermal power plant. Environmental pollution limits guidelines for thermal power plant pollution control. Various pollution control equipment such as dust collector, bag filter, electrostatic separator, working principle and selection criteria, designing the pollution control system, methods and limitation. Water pollution in thermal power plant, physical and chemical methods of pollution control, Land pollution effect of land pollution, measurement of land pollution, Limitations and advantages of pollution control systems. Hydrothermal plant environmental assessment, hydrothermal plant and rehabilitation measures for hydrothermal plant	9
UNIT-III	
Pollution due to Nuclear power plants Nuclear power plants and environmental pollution, pollution control measures **Industrial and Urban Waste & Waste Energy Recovery** (C-1.0, L-10) Industrial waste, Waste and effluent treatment, Waste as a source of energy: Industrial, domestic and solid waste as a source of energy. Pollution control: Causes, process and exhaust gases and its control, mechanism and devices for pollution control.	9
UNIT-IV	
Environmental and Pollution Control Laws United Nations Framework Convention on Climate Change (UNFCC), Protocol, Conference of Parties (COP)19 Clean Development Mechanism (CDM), Prototype Carbon Funds(PCF) Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project. **Global Environmental Concern** Global Environmental Issues, ozone layer depletion, Global Warming, Green House Gases Emission	9

Textbooks	
1.	Management of Energy Environment Systems -W.K. Foell (John Wiley and Sons).
2.	Energy Management and Control Systems -M.C. Macedo Jr. (John Wiley and Sons).
Reference books	
1.	Environmental Impact Analysis Handbook -J.G. Rau, D.C. Wood (McGraw Hill).
2.	Energy & Environment – J.M. Fowler. (McGraw Hill)

2017.3.13 **शैक्षिक सत्र 2017-18 के आड सेमेस्टर के समस्त M.Tech., MCA एवं MBA के पाठ्यक्रमों हेतु बोर्ड आफ स्टडीज द्वारा अनुमोदित परीक्षकों की सूची का अवलोकन एवं एवं विभिन्न स्नातक/परास्नातक पाठ्यक्रमों के सैलेबस में आंशिक संशोधन सहित सत्र 2017-18 के आड सेमेस्टर से प्रभावी किये जाने का अनुमोदन।**

शैक्षिक सत्र 2017-18 के आड सेमेस्टर के समस्त M.Tech., MCA एवं MBA पाठ्यक्रमों हेतु विभागीय बोर्ड आफ स्टडीज द्वारा संस्तुत लिखित एवं प्रायोगिक परीक्षा का पैनल प्राप्त किया गया, जिसे मा0 कुलपति महोदय के अनुमोदनोपरान्त परीक्षा नियंत्रक को अग्रिम कार्यवाही हेतु प्रेषित किया गया।

निम्न विभागो द्वारा पाठ्यक्रमों में किये गये संशोधन पृष्ठ संख्या 142 से पृष्ठ संख्या 150 पर संलग्न है। पाठ्यक्रमों का विवरण निम्नवत् है:-

विभाग	विषय कोड	विषय का नाम	प्रभावी होने का सत्र
प्रयुक्त विज्ञान विभाग	MAS-101 A	Numerical Methods and Engineering Optimization	2018-19
	MAS-112 A	Advanced Engineering Mathematics	2018-19
	MAS-113 A	Probabilistic Modelling	2017-18
विद्युतकण एवं संचार अभि0 विभाग	MEC - 167	Organic Electronics Devices and Circuits	2018-19

विद्या परिषद के माननीय सदस्यों से अनुरोध है कि कृपया उक्त का अनुमोदन प्रदान करने की कृपा करें।

DEPARTMENT OF APPLIED SCIENCES
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY
GORAKHPUR

Minutes of Board of Studies of Department of Applied Sciences M.M.M. University of Technology, Gorakhpur held on Dated: 23.09.2017

The Following were present:-

1.	Dr. B. K. Pandey	Chairman
2.	Prof. D. K. Dwivedi	Member Internal
3.	Dr. D. Kandu	Member Internal
4.	Dr. P.P. Pande	Member Internal
5.	Dr. S.P. Singh	Member Internal
6.	Dr. A.K Barnwal	Member Internal
7.	Dr Harish chandra	Member Internal
8.	Sri Ravi Kumar Gupta	Member Internal
9.	Dr. Krishna Kumar	Member Internal
10.	Dr. Abhijit Mishra	Member Internal
11.	Dr. Abhishek Kr. Gupta	Member Internal
12.	Dr. Ram Keval	Member Internal
13.	Prof Sanjay Chaubey	Member External
14.	Prof G. Anantharaman	Member External

The Following decisions were taken

1. The list of Examiners for Theory & Practical Examination of Mathematics & Humanities for ODD Semester 2017-18 session was prepared.
2. The revised syllabus of Advanced Engineering Mathematics (MAS-112) has been recommended, which will be effective from the session 2018-19.
3. The revised syllabus of Numerical Method & Engineering Optimization (MAS-101) has been recommended, which will be effective from the session 2018-19.
4. The revised syllabus of Probabilistic Modeling (MAS-113) has been recommended, which will be effective from the session 2017-18 (Even Semester).

The meeting ended with thanks to the chairman

HASD

No. MUT/Appl. Sc./ /2017 Date: 23Sept . 2017

Copy for information & necessary action to:-

1. Dean PGS, R&D

HASD

MAS 101	Numerical Methods and Engineering Optimization		
Course category	:	Basic Sciences & Maths (BSM)	
Pre-requisites	:	NIL	
Contact hours/week	:	Lecture: 3, Tutorial: 1 , Practical: 2	
Number of Credits	:	5	
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes, Minor and Major Theory & Practical Examination	
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course	
1. To find the root of a curve using iterative methods 2. To interpolate a curve using Gauss, Newton's interpolation formula. 3. Use the theory of optimization methods and algorithms developed for various types of optimization problems. 4. To apply the mathematical results and numerical techniques of optimization theory to Engineering problems.			
Topics Covered			
UNIT-I			
Numerical Methods I: Solution of algebraic and transcendental equations by Bisection, Regula-Falsi and Newton-Raphson methods. Interpolation: Newton's forward and backward interpolation formulae, Lagrange's formula and Newton's divided difference formula.			9
UNIT-II			
Numerical Methods II: Solution of system of linear equations by Gauss Jacobi method, Guass-Siedel method, Relaxation method and LU decomposition method, Cholesky method. Numerical differentiation, Numerical Integration: Trapezoidal Rule, Simpson's one-third and three-eight rules.			9
UNIT-III			
Classical Optimization Techniques: Introduction, Review of single and multi-variable optimization methods with and without constraints, Non-linear one-dimensional minimization problems, Examples.			9
UNIT-IV			
Constrained Optimization Techniques: Introduction, Direct Methods, Cutting plane method, Indirect methods, Convex programming problems, Exterior penalty function method, Examples and			9

problems. Unconstrained optimization techniques: Introduction, Descent methods, Steepest Descent methods Newton's method, Quasi-Newton's method.

Experiments:

1. To implement Regula Falsi method to solve algebraic equations.
2. To implement numerical integration to solve algebraic equations.
3. To implement Gauss-Siedel method for solution of simultaneous equations.
4. To implement Runge-Kutta method of order four to solve differential equations.
5. To implement Euler's method to find solution of differential equations.
6. To find optimum solution to problem parameters.
7. To find derivatives of static displacements and stresses.
8. To write Computer based algorithm and program for solution of Eigen-value problems.
9. Reduction of size of an optimization problem using Reduced basis technique.
10. To find Derivatives of Eigen-values and Eigen vectors.

Textbooks

1.	Engineering Optimization: S.S.Rao; New Age International.
2.	Applied Optimal Design: E.J. Haug and J.S. Arora; Wiley New York.
3.	P. Kandasamy, K. Thilagavathy &| K. Gunavathy, Numerical Methods, Schand Publishers.

MAS 112	Advanced Engineering Mathematics	
Course category	:	Basic Sciences & Maths (BSM)
Pre-requisites	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes, Minor and Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. to find out the dimension of vector spaces
2. describe the differences between finite-difference and finite-element methods for solving PDEs;
3. solve Elliptical (Laplace/Poisson) PDEs using finite differences;
4. solve functional using Euler method.

Topics Covered	
UNIT-I	
Vector spaces and Linear transformation: Vector spaces, subspaces, Linear dependence, Basis and Dimension, Linear transformations, Kernel & images, matrix representation of linear transformation, change of basis, Eigen values and Eigen vectors of linear operators, diagonalization.	9
UNIT-II	
Numerical Techniques: Solution of algebraic and transcendental equations using bisection, Regula Falsi and Newton Raphson's method, Numerical solution to linear system, LU factoring decomposition, Cholesky method, Gauss Seidal method, Numerical eigen value problem, Jacobi, Givens method	9
UNIT-III	
Calculus of Variation: Functionals, Euler's equation and its generalization. One and several independent variables. Initial value problems. Weierstrass's sufficiency condition for weak and strong minima and maxima	9
UNIT-IV	
Numerical Solution of Partial Differential Equations: Classification of partial differential equations of the second order. Laplace equations and its solution by Liebmann's process. Poisson equation. Solution of Parabolic, Eliptic and Hyperbolic Equations. Applications to Engineering.	9

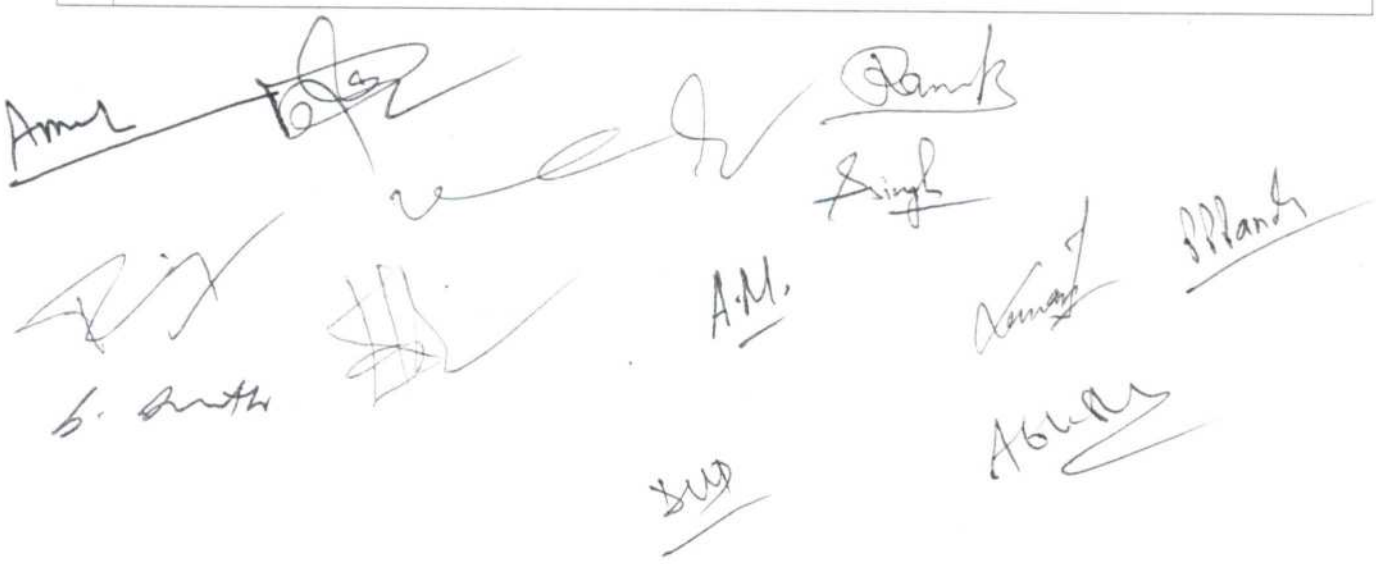
Textbooks	
1.	K. Hoffman, R Kunze, Linear Algebra, Prentice Hall of India, 1971.
2.	I. M. Gelfrand, S. V. Fomin, Calculus of Variation, Dover Publications.
3.	M. D. Raisinghania, Advanced Differential Equations, Schand Publishers.

MAS 113	Probabilistic Modelling		
Course category	:	Basic Sciences & Maths (BSM)	
Pre-requisites	:	NIL	
Contact hours/week	:	Lecture: 3, Tutorial: 1 , Practical: 2	
Number of Credits	:	5	
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes and Minor and Major Theory & Practical Examination	
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course	

1. define, illustrate, and apply the concepts of probability;
2. analyze and interpret statistical data using appropriate probability distributions
3. define, illustrate, and apply the concepts of discrete and continuous random variables
4. understand the concept of Queuing models and apply appropriate queuing model, mainly M/M/1 model.

Topics Covered	
UNIT-I	
Probability and Probability distributions: Definition, sample space, conditional probability, Baye's theorem, Bernouli's trials, Brief Introduction of Binomial, Poisson and Normal distributions with their applications.	9
UNIT-II	
Random Variables: Random Variables, Distribution and Density functions, Moment and Moment generating functions, Independent Random Variables, Marginal and Conditional Distributions, Conditional Expectation.	9
UNIT-III	
Queuing Theory: Single and Multiple server Markovian queueing models - customer impatience - Priority queues - M/M/1 queueing system - queueing theory applications.	9
UNIT-IV	
Statistical Hypothesis: Concept of Statistical Hypothesis, hypothesis, Procedure of testing the hypothesis, Types of Error, Level of Significance, Degree of freedom. Chi-Square Test, Properties, and Constants of Chi-Square Distribution. Student's t-Distribution, Properties & Applications of t-Distribution. Analysis of Variance, F-Test, Properties & Applications of F-Test.	9

COMPUTER PROGRAMMING LAB	
Implement a C programme to calculate Probability, Means, Moments, Variance, Skewness, Standard Deviation, Coefficient of Variation. C program to generate random numbers, to implement various queue operations.	
Textbooks	
1.	V. Rohatgi., An Introduction to probability and Mathematical Statistics, Wiley Eastern Ltd. New Delhi.
2.	J.K. Sharma, Operation Research, Laxmi Publications.
3.	K. Swaroop, P. K. Gupta, Man Mohan, Operation Research, Sultan chand Publishers.



2017.3.13 **शैक्षिक सत्र 2017-18 के आड सेमेस्टर के समस्त M.Tech., MCA एवं MBA के पाठ्यक्रमों हेतु बोर्ड आफ स्टडीज द्वारा अनुमोदित परीक्षकों की सूची का अवलोकन एवं एवं विभिन्न स्नातक/परास्नातक पाठ्यक्रमों के सैलेबस में आंशिक संशोधन सहित सत्र 2017-18 के आड सेमेस्टर से प्रभावी किये जाने का अनुमोदन।**

शैक्षिक सत्र 2017-18 के आड सेमेस्टर के समस्त M.Tech., MCA एवं MBA पाठ्यक्रमों हेतु विभागीय बोर्ड आफ स्टडीज द्वारा संस्तुत लिखित एवं प्रायोगिक परीक्षा का पैनल प्राप्त किया गया, जिसे मा0 कुलपति महोदय के अनुमोदनोपरान्त परीक्षा नियंत्रक को अग्रिम कार्यवाही हेतु प्रेषित किया गया।

निम्न विभागो द्वारा पाठ्यक्रमों में किये गये संशोधन पृष्ठ संख्या 142 से पृष्ठ संख्या 150 पर संलग्न है। पाठ्यक्रमों का विवरण निम्नवत् है:-

विभाग	विषय कोड	विषय का नाम	प्रभावी होने का सत्र
प्रयुक्त विज्ञान विभाग	MAS-101 A	Numerical Methods and Engineering Optimization	2018-19
	MAS-112 A	Advanced Engineering Mathematics	2018-19
	MAS-113 A	Probabilistic Modelling	2017-18
विद्युतकण एवं संचार अभि0 विभाग	MEC - 167	Organic Electronics Devices and Circuits	2018-19

विद्या परिषद के माननीय सदस्यों से अनुरोध है कि कृपया उक्त का अनुमोदन प्रदान करने की कृपा करें।

DEPARTMENT OF APPLIED SCIENCES
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY
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Minutes of Board of Studies of Department of Applied Sciences M.M.M. University of Technology, Gorakhpur held on Dated: 23.09.2017

The Following were present:-

1.	Dr. B. K. Pandey	Chairman
2.	Prof. D. K. Dwivedi	Member Internal
3.	Dr. D. Kandu	Member Internal
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6.	Dr. A.K Barnwal	Member Internal
7.	Dr Harish chandra	Member Internal
8.	Sri Ravi Kumar Gupta	Member Internal
9.	Dr. Krishna Kumar	Member Internal
10.	Dr. Abhijit Mishra	Member Internal
11.	Dr. Abhishek Kr. Gupta	Member Internal
12.	Dr. Ram Keval	Member Internal
13.	Prof Sanjay Chaubey	Member External
14.	Prof G. Anantharaman	Member External

The Following decisions were taken

1. The list of Examiners for Theory & Practical Examination of Mathematics & Humanities for ODD Semester 2017-18 session was prepared.
2. The revised syllabus of Advanced Engineering Mathematics (MAS-112) has been recommended, which will be effective from the session 2018-19.
3. The revised syllabus of Numerical Method & Engineering Optimization (MAS-101) has been recommended, which will be effective from the session 2018-19.
4. The revised syllabus of Probabilistic Modeling (MAS-113) has been recommended, which will be effective from the session 2017-18 (Even Semester).

The meeting ended with thanks to the chairman

HASD

No. MUT/Appl. Sc./ /2017 Date: 23Sept . 2017

Copy for information & necessary action to:-

1. Dean PGS, R&D

HASD

MAS 101	Numerical Methods and Engineering Optimization		
Course category	:	Basic Sciences & Maths (BSM)	
Pre-requisites	:	NIL	
Contact hours/week	:	Lecture: 3, Tutorial: 1 , Practical: 2	
Number of Credits	:	5	
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes, Minor and Major Theory & Practical Examination	
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course	
1. To find the root of a curve using iterative methods 2. To interpolate a curve using Gauss, Newton's interpolation formula. 3. Use the theory of optimization methods and algorithms developed for various types of optimization problems. 4. To apply the mathematical results and numerical techniques of optimization theory to Engineering problems.			
Topics Covered			
UNIT-I			
Numerical Methods I: Solution of algebraic and transcendental equations by Bisection, Regula-Falsi and Newton-Raphson methods. Interpolation: Newton's forward and backward interpolation formulae, Lagrange's formula and Newton's divided difference formula.			9
UNIT-II			
Numerical Methods II: Solution of system of linear equations by Gauss Jacobi method, Guass-Siedel method, Relaxation method and LU decomposition method, Cholesky method. Numerical differentiation, Numerical Integration: Trapezoidal Rule, Simpson's one-third and three-eight rules.			9
UNIT-III			
Classical Optimization Techniques: Introduction, Review of single and multi-variable optimization methods with and without constraints, Non-linear one-dimensional minimization problems, Examples.			9
UNIT-IV			
Constrained Optimization Techniques: Introduction, Direct Methods, Cutting plane method, Indirect methods, Convex programming problems, Exterior penalty function method, Examples and			9

problems. Unconstrained optimization techniques: Introduction, Descent methods, Steepest Descent methods Newton's method, Quasi-Newton's method.

Experiments:

1. To implement Regula Falsi method to solve algebraic equations.
2. To implement numerical integration to solve algebraic equations.
3. To implement Gauss-Siedel method for solution of simultaneous equations.
4. To implement Runge-Kutta method of order four to solve differential equations.
5. To implement Euler's method to find solution of differential equations.
6. To find optimum solution to problem parameters.
7. To find derivatives of static displacements and stresses.
8. To write Computer based algorithm and program for solution of Eigen-value problems.
9. Reduction of size of an optimization problem using Reduced basis technique.
10. To find Derivatives of Eigen-values and Eigen vectors.

Textbooks

1.	Engineering Optimization: S.S.Rao; New Age International.
2.	Applied Optimal Design: E.J. Haug and J.S. Arora; Wiley New York.
3.	P. Kandasamy, K. Thilagavathy &| K. Gunavathy, Numerical Methods, Schand Publishers.

MAS 112	Advanced Engineering Mathematics	
Course category	:	Basic Sciences & Maths (BSM)
Pre-requisites	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes, Minor and Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. to find out the dimension of vector spaces
2. describe the differences between finite-difference and finite-element methods for solving PDEs;
3. solve Elliptical (Laplace/Poisson) PDEs using finite differences;
4. solve functional using Euler method.

Topics Covered	
UNIT-I	
Vector spaces and Linear transformation: Vector spaces, subspaces, Linear dependence, Basis and Dimension, Linear transformations, Kernel & images, matrix representation of linear transformation, change of basis, Eigen values and Eigen vectors of linear operators, diagonalization.	9
UNIT-II	
Numerical Techniques: Solution of algebraic and transcendental equations using bisection, Regula Falsi and Newton Raphson's method, Numerical solution to linear system, LU factoring decomposition, Cholesky method, Gauss Seidal method, Numerical eigen value problem, Jacobi, Givens method	9
UNIT-III	
Calculus of Variation: Functionals, Euler's equation and its generalization. One and several independent variables. Initial value problems. Weierstrass's sufficiency condition for weak and strong minima and maxima	9
UNIT-IV	
Numerical Solution of Partial Differential Equations: Classification of partial differential equations of the second order. Laplace equations and its solution by Liebmann's process. Poisson equation. Solution of Parabolic, Eliptic and Hyperbolic Equations. Applications to Engineering.	9

Textbooks	
1.	K. Hoffman, R Kunze, Linear Algebra, Prentice Hall of India, 1971.
2.	I. M. Gelfrand, S. V. Fomin, Calculus of Variation, Dover Publications.
3.	M. D. Raisinghania, Advanced Differential Equations, Schand Publishers.

MAS 113	Probabilistic Modelling		
Course category	:	Basic Sciences & Maths (BSM)	
Pre-requisites	:	NIL	
Contact hours/week	:	Lecture: 3, Tutorial: 1 , Practical: 2	
Number of Credits	:	5	
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes and Minor and Major Theory & Practical Examination	
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course	

1. define, illustrate, and apply the concepts of probability;
2. analyze and interpret statistical data using appropriate probability distributions
3. define, illustrate, and apply the concepts of discrete and continuous random variables
4. understand the concept of Queuing models and apply appropriate queuing model, mainly M/M/1 model.

Topics Covered	
UNIT-I	
Probability and Probability distributions: Definition, sample space, conditional probability, Baye's theorem, Bernouli's trials, Brief Introduction of Binomial, Poisson and Normal distributions with their applications.	9
UNIT-II	
Random Variables: Random Variables, Distribution and Density functions, Moment and Moment generating functions, Independent Random Variables, Marginal and Conditional Distributions, Conditional Expectation.	9
UNIT-III	
Queuing Theory: Single and Multiple server Markovian queueing models - customer impatience - Priority queues - M/M/1 queueing system - queueing theory applications.	9
UNIT-IV	
Statistical Hypothesis: Concept of Statistical Hypothesis, hypothesis, Procedure of testing the hypothesis, Types of Error, Level of Significance, Degree of freedom. Chi-Square Test, Properties, and Constants of Chi-Square Distribution. Student's t-Distribution, Properties & Applications of t-Distribution. Analysis of Variance, F-Test, Properties & Applications of F-Test.	9

COMPUTER PROGRAMMING LAB	
Implement a C programme to calculate Probability, Means, Moments, Variance, Skewness, Standard Deviation, Coefficient of Variation. C program to generate random numbers, to implement various queue operations.	
Textbooks	
1.	V. Rohatgi., An Introduction to probability and Mathematical Statistics, Wiley Eastern Ltd. New Delhi.
2.	J.K. Sharma, Operation Research, Laxmi Publications.
3.	K. Swaroop, P. K. Gupta, Man Mohan, Operation Research, Sultan chand Publishers.