Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Enlightening Technical Minds Estd. 1998
An Autonomous Institution (Since 2011)

Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Affiliated to Anna University, Chennai; Approved by AICTE ; Accredited by NAAC with Grade 'A++'
Accredited by NBA - Tier1 (Mech, Auto, Civil, EEE, ECE, E&I and CSE)
Udumalai Road, Pollachi - 642 003 Tel: 04259-236030/40/50 Fax: 04259-236070 www.mcet.in

Curriculum and Syllabi

M.E. CAD/CAM

SEMESTER I to IV

Regulations 2019

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Department of Mechanical Engineering

Vision:

To transform students from rural background into professional leaders of tomorrow in the field of Production Engineering with a strong sense of social commitment

Mission:

- To impart quality -Engineering education leading to specialization in the emerging areas of CAD/CAM/CAE, Tool & Die Making, Product Styling & Design, Machine Vision Systems and Materials Technology.
- To provide - continually updated and intellectually stimulating environment to pursue research and consultancy activities.

OBE Coordinator

Programme Coordinator

Head of the Department

Head - OBE

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Programme: M.E. CAD/CAM

Programme Educational Objectives (PEOs) - Regulation 2019

After 2 to 3 years of completion of the programme the graduates will be able to:

PEO1. Actively advance, engineering of products with elaborate modeling, simulation and analysis by scholarly research

PEO2. Constantly improves systems for increasing productivity in organizations.

Programme Outcomes (POs) - Regulations 2019

On successful completion of the programme the graduates will be able to:

PO1. Solve engineering problems after evaluating a wide range of potential solutions for those problems and arrive at feasible, optimal solutions with due consideration for public health, safety, cultural, societal and environmental factors.

PO2. Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data.

PO3. Communicate with the engineering community and with society at large, regarding complex engineering activities by being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, and making effective presentations.

PO4. Use engineering, management and IT tools for prediction and modeling of complex engineering activities with an understanding of the limitations.

OBE Coordinator

Programme Coordinator

Head of the Department

Head - OBE

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Programme: M.E CAD/CAM

2019 Regulations

Curriculum for Semesters I to IV

SEMESTER I

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19CCFN1101	Mathematical Methods in Engineering	3	0	0	3	100	-
19CCCN1101	CNC Machines and Programming	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective - I	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective - II	3	0	0	3	100	-
19COFG1101	Research Methodology and IPR	3	0	0	3	100	All
19CCCN2101	CAD Laboratory	0	0	4	2	100	-
19CCCN2102	CAM Laboratory	0	0	4	2	100	-
19SHAG1101	English for Research Paper Writing	2	0	0	-	100	All
Total		**17**	**0**	**8**	**19**	**800**	

SEMESTER II

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19CCCN1201	Finite Element Method	3	0	0	3	100	-
19CCCN1202	Applied Materials Engineering	3	0	0	3	100	-
19CCCN1203	Integrated Product and Processes Development	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective - III	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective - IV	3	0	0	3	100	-
19CCCN2201	CAE Laboratory	0	0	4	2	100	-
19CCPN3201	Mini Project with Seminar	0	0	4	2	100	-
19SHAG1201	Teaching and Learning in Engineering	2	0	0	-	100	All
Total		**17**	**0**	**8**	**19**	**800**	

Passed in Board of Studies meeting held on 02.04.19

BOS Convener

Approved in Academic Council meeting held on 27.07.19

BOS Chairman

SEMESTER III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
xxxxxxxxxx	Professional Elective - V	3	0	0	3	100	-
xxxxxxxxxx	Open Elective	3	0	0	3	100	-
19CCPN5301	Project - I	0	0	20	10	200	-
Total		**6**	**0**	**20**	**16**	**400**	

SEMESTER IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19CCPN5401	Project - II	0	0	32	16	400	-
Total		**0**	**0**	**32**	**16**	**400**	

Total Credits: 70

Passed in Board of Studies meeting held on 02.04.19

BOS Convener

Approved in Academic Council meeting held on 27.07.19

BOS Chairman

PROFESSIONAL ELECTIVES - I

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CCEN1101	Advanced Vibrations and Acoustics	3	0	0	3	100
19CCEN1102	Advanced Strength of Materials	3	0	0	3	100
19CCEN1103	Computational Fluid Dynamics	3	0	0	3	100
19CCEN1104	Welding Metallurgy	3	0	0	3	100

PROFESSIONAL ELECTIVES - II

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CCEN1105	Flexible Competitive Manufacturing System	3	0	0	3	100
19CCEN1106	Product Data Management	3	0	0	3	100
19CCEN1107	Productivity Management and Re-Engineering	3	0	0	3	100
19CCEN1108	Corrosion and Surface Engineering	3	0	0	3	100

PROFESSIONAL ELECTIVES - III

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CCEN1201	Industrial Robotics and Artificial Intelligence	3	0	0	3	100
19CCEN1202	Additive Manufacturing	3	0	0	3	100
19CCEN1203	Metrology and Non Destructive Testing	3	0	0	3	100
19CCEN1204	Reliability and Quality Engineering	3	0	0	3	100

PROFESSIONAL ELECTIVES - IV

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CCEN1205	Design for Manufacture, Assembly and Environment	3	0	0	3	100
19CCEN1206	Computer Aided Process Planning	3	0	0	3	100
19CCEN1207	Modeling and Analysis of Manufacturing Systems	3	0	0	3	100
19CCEN1208	Design and Analysis of Thermal Systems	3	0	0	3	100
19CCEN1209	Experimental Methods and Analysis	3	0	0	3	100
19CCEN1210	Biological Nano Structure	3	0	0	3	100

Passed in Board of Studies meeting held on 02.04.19

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Approved in Academic Council meeting held on 27.07.19

BOS Chairman

PROFESSIONAL ELECTIVES - V

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CCEN1301	Tribology in Design	3	0	0	3	100
19CCEN1302	Mechanics of Composite Materials	3	0	0	3	100
19CCEN1303	Optimization Techniques in Design	3	0	0	3	100
19CCEN1304	Material Testing and Characterization Technique	3	0	0	3	100

OPEN ELECTIVES

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19CCON1301	Automation Systems	3	0	0	3	100
19CCON1302	Enterprise Resource Planning	3	0	0	3	100

Passed in Board of Studies meeting held on 02.04.19

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Approved in Academic Council meeting held on 27.07.19

BOS Chairman

Regulations 2019

Detailed Syllabi for Semesters I to IV

SEMESTER I

Course Code: 19CCFN1101	Course Title: MATHEMATICAL METHODS IN ENGINEERING		
Course Category: Foundation Courses		Course Level: Practice	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Solve the variational problems with boundary conditions.
2. Solve the system of linear equations and apply numericaltechniques to evaluate integrals.
3. Identify and solve engineering problems by applying the knowledge of partial differential equations.
4. Interpret the notion of sampling distributions and statistical techniques used in engineering problems.
5. Explain the systematic problem solving techniques using design of experiments.

UNIT I CALCULUS OF VARIATIONS **9 Hours**

Variation and its properties –Euler's equation – Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables – Rayleigh Ritz method- Galerkin method.

UNIT II SYSTEM OF LINEAR EQUATIONS AND NUMERICAL INTEGRATION **9 Hours**

Solving the set of equations, Choleski method, Iterative methods, Relaxation method, Trapezoidal rule, Simpson's rules, Gaussian quadrature, Examples.

UNIT III HIGHER ORDER PARTIAL DIFFERENTIAL EQUATIONS **9 Hours**

Second order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation. Separation of variables method to simple problems in Cartesian coordinates. One dimensional diffusion equation and its solution by separation of Variables.

UNIT IV TESTING OF STATISTICAL HYPOTHESIS **9 Hours**

Statistical hypothesis, Large sample test based on Normal distribution for single mean and difference of means, Tests based on t, Chi-square and F distributions for mean, variance and proportion, Contingency table (test for independent),Goodness of fit.

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UNIT V DESIGN OF EXPERIMENTS **9 Hours**

Aim of Design of Experiments-Basic Principles of Experimental Design-Completely Randomized Design(CRD)-Analysis of Variance(AVOVA)- Randomized Design(RBD)-Latin Square Design(LSD)-Comparison of RBD and LSD.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Solve the variational problems with boundary conditions.	Apply
CO2: Solve the system of linear equations & apply numericaltechniques to evaluate integrals.	Apply
CO3: Identify and solve engineering problems by applying the knowledge of partial differential equations.	Apply
CO4: Interpret the notion of sampling distributions and statistical techniques used in engineering problems.	Apply
CO5: Select systematic problem solving techniques using design of experiments.	Apply

Reference Book(s):

R1. Curtis F Gerald and Patrick O Wheatley, "Applied Numerical Analysis", Second Edition, PHI Learning Private Limited, New Delhi, 2012

R2. T.Veerarajan, "Probability, Statistics and Random Process", 2nd Edition, Tata McGraw-Hill, New Delhi,2009

R3. Advanced Engineering Mathematics (9th Edition), Erwin Kreyszig, Wiley India,2013

R4. P.Kandasamy,K.Thilagavathy,K.Gunavathy,"Numerical Methods" S.CHAND, First Edition 1997.

R5. S. P. Gupta, Statistical Methods, S. Chand & Sons, 37th revised edition, 2008

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

Course Code: 19CCCN1101	Course Title: CNC MACHINES AND PROGRAMMING		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the different CNC machining center.
2. Explain the basic structure of different CNC machining center.
3. Explain the different drives and controllers of CNC machine tool.
4. Select a suitable tool and work holding device.
5. Develop a CNC part programming.

UNIT I - INTRODUCTION TO CNC MACHINE TOOLS **9 Hours**

Evolution of CNC Technology - principles - features - advantages - applications - CNC and DNC concept - CNC controllers - characteristics - interpolators - types of CNC Machines - turning centre - machining centre - grinding machine - vertical turret lathe - turn-mill centre - EDM

UNIT II - STRUCTURE CNC MACHINE TOOL ELEMENTS **9Hours**

Configuration of the CNC systems, Specifications of CNC Turning andMachining center, Advantages of the CNC machines, CNC Turning center development,Tool monitoring on CNC machines. Machine structure.

UNIT III - DRIVES AND CONTROLS **9Hours**

Machine Drives: Spindle drives, Feed drives, DC motors, DC servomotors, AC servomotors, Guide ways, Ball screw and nut assembly - Feedback devices: Encoders, Relays, Solenoids, Sensors and their types - Interfacing: Parallel and Serial Communications.

UNIT IV -TOOLING AND WORK HOLDING DEVICES **9Hours**

Cutting tool materials for CNC machine tools- hard metal insert tooling- inserts and tool holder classification - qualified - semi qualified and preset tooling - ATC - APC - tooling for machining and turning centre - silent tool - work holding devices for rotating and fixed work parts- economics of CNC - maintenance of CNC machines.

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UNIT V - CNC PART PROGRAMMING **9Hours**

Coordinate system - structure of a CNC part program - G & M Codes - tool length compensation - cutter radius and tool nose radius compensation - do loops - subroutines - canned cycles- mirror image - parametric programming - machining cycles- programming for machining centre and turning centre for well-known controllers such as Fanuc - Sinumerik etc.- generation of CNC codes from CAM packages.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the different CNC machining center for producing parts in automobile, aerospace and other part development industries.	Understand
CO2: Explain the basic structure of different CNC machining center to machine different geometric component.	Understand
CO3: Explain the different drives and controllers of CNC machine tool to machine given component.	Understand
CO4: Select a suitable tool and work holding device based on geometry of the work piece.	Apply
CO5: Develop a CNC part programming for a given component.	Apply

Reference Book(s):

R1. Radhakrishnan .P, "Computer Numerical Control CNC Machines" New central book agency, 2013.

R3. Mike Mattson., "CNC Programming Principles and Applications", Delmar Cengage learning, 2010.

R4. YoramKoren, "Computer Control of Manufacturing Systems", Mc-Graw Hill book co, 2006.

R5. S. K Sinha, "CNC Programming using Fanuc Custom Macro B", Mc-Graw Hill book co, 2011.

Web References:

1. http://nptel.ac.in
2. https://mit.edu/courses/mechanical-engineering

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

19COFG1101

Course Code:19COCG1101	Course Title: RESEARCH METHODOLOGIES AND IPR (common to all PG Programmes)		
Course Category: Foundation Courses		Course Level: Introductory	
L:T:P: 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Describe the overview of research methodology.
2. Explain the attitude measurements, scales and sampling methods
3. Apply hypotheses testing in research problem
4. Elucidate the research report writing and presentation effectively.
5. Apply patent and copyright for their innovative works.

UNIT IOVERVIEW OF RESEARCH METHODOLOGY — 9 Hours

Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process

Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

UNIT II ATTITUDE MEASUREMENTS, SCALES AND SAMPLING METHODS — 9 Hours

Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non- probability sampling method – convenience sampling, judgment sampling, quota sampling.

UNIT III HYPOTHESES TESTING — 10 Hours

Hypotheses testing – Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests)

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UNIT 4 REPORT WRITING AND PRESENTATION — 8 Hours

Report writing- Types of report, guidelines to review report, typing instructions, oral presentation

UNIT 5 PATENTING — 9 Hours

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1. Describe the overview of research methodology.	Understand
CO 2. Explain the attitude measurements, scales and sampling methods	Understand
CO 3. Apply hypotheses testing in research problem.	Apply
CO 4. Elucidate the research report writing and presentation effectively.	Understand
CO 5: Apply patent and copyright for their innovative works	Apply

Reference Book(s):

R1. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.

R2. Kumar, Ranjit, , "Research Methodology: A Step by Step Guide for beginners", London Sage: Publications, 2005.

R3. Halbert, "Resisting Intellectual Property", Taylor & Francis Publications ,2007.

R4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in NewTechnological Age", Clause 8 Publishing, 2016.

R5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand Publications, 2008.

Passed in Board of Studies meeting held on 02.04.19

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Approved in Academic Council meeting held on 27.07.19

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Course Code:19CCCN2101	Course Title: CAD LABORATORY		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 0: 0: 4	Credits:2	Total Contact Hours:60	Max Marks:100

Course Objectives

The course is intended to:

1. Familiarize with Indian standards on drawing practices and standard components.
2. Understand and interpret drawings of machine components.
3. Develop assembly drawings using standard CAD packages.
4. Demonstrate practical experience in handling 2D drafting and 3D modeling software systems.

Area of Experiments:

1. Study of Drawing Standards and Fits and Tolerances
2. Preparation 2D Drafting of Plummer block bearing
3. Preparation 2D Drafting of Non-return valves
4. Preparation 2D Drafting of Safety valve
5. Preparation of Knuckle joint assembly drawing
6. Preparation of Flange coupling assembly drawing
7. Preparation of Screw Jack assembly drawing
8. Preparation of Universal Coupling assembly drawing
9. Preparation of 3D Assembly of Piston and connecting rod
10. Preparation of 3D Assembly Machine vice
11. Preparation of 3D Assembly Stuffing box

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explainthe drawing standards, fits and tolerances	Understand
CO2: Manipulate and Re-Model part drawings, sectional views drawings as per standards	Apply
CO3: Dramatize assembly drawings of machine components using modelling software.	Apply

Reference (s):

R1. K.L.Narayana, P.Kannaiah, K.Venketa Reddy, " Text book for Machine Drawing" New Age International Pvt Ltd,2009

R2. CAD Laboratory Manual

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Course Code:19CCCN2102	Course Title: CAM LABORATORY		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 0: 0: 4	Credits:2	Total Contact Hours:60	Max Marks:100

Course Objectives

The course is intended to:

1. Write CNC programming to machine the mechanical components.

AREA OF EXPERIMENTS:

1. Write part program for simple facing operation and simulate by using CNC Tutor
2. Write part program for simple turning operation and simulate by using CNC Tutor
3. Write part program for box facing operation and simulate by using CNC Tutor
4. Write part program for box turning operation and simulate by using CNC Tutor
5. Write part program for multiple facing operation and simulate by using CNC Tutor
6. Write part program for multiple turning operation and simulate by using CNC Tutor
7. Write part program for grooving operation and simulate by using CNC Tutor
8. Write part program for peek drilling operation and simulate by using CNC Tutor
9. Write part program for threading operation and simulate by using CNC Tutor
10. Write part program for profile milling operation and simulate by using CNC Tutor
11. Write part program for peck drilling operation and simulate by using CNC Tutor
12. Write part program for profile milling and circular picketing operation and simulate by using CNC Tutor
13. Write part program for profile milling and rectangular picketing operation and simulate by using CNC Tutor
14. Turning operation using EDGE CAM
15. Milling operation using EDGE CAM

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BOS Chairman

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Develop the CNC programming to machine the mechanical components.	Apply

Reference (s):

R1. Radhakrishnan .P. "Computer Numerical Control CNC Machines" New central book agency, 2013

R2. https://nptel.ac.in/courses/112103174/35

Passed in Board of Studies meeting held on 02.04.19

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BOS Chairman

Course Code: 19SHAG1101	Course Title: ENGLISH FOR RESEARCH PAPER WRITING (Common to all PG Programmes)	
Course Category: Audit Courses	Course Level: Introductory	
L:T:P: 2:0:0	Total Contact Hours: 30	Max Marks:100

Course Objectives

The course is intended to:

1.Describe how to improve the writing skills and level of readability

2.Apply research writing skills in each section

3.Explain the skills needed when writing titles

UNIT 1- RESEARCH PLAN AND PREPARATORY TOOLS **10 Hours**

Plan - Word Order - Break up long sentences - Paragraph and Sentence Structures - Concise and Remove Redundancy - Avoid Ambiguity and Vagueness - Preparation

UNIT 2- GRAMMAR FOR RESEARCH **10 Hours**

Expand the vocabulary & phrases – Grammar & punctuation - Ensure the content - Review of the Literature - Conclusions

UNIT 3- KEY SKILLS FOR PREPARATION **10 Hours**

Clarify Who Did What – Highlight the Findings - Hedge and Criticise - Paraphrase - Check Plagiarism - Sections of a Paper - Abstracts –Introduction - Key skills needed when writing - a Title, an Abstract, an Introduction, a Review of the Literature, Methods, Results, Discussion, Conclusions

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Describe how to improve the writing skills and level of readability	Understand
CO 2: Apply research writing skills in each section	Apply
CO 3: Use the skills needed when writing titles	Apply

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Reference Book(s):

R1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

R2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006

R3. Kumar, Ranjit,"Research Methodology: A Step by Step Guide for beginners", London Sage: Publications, 2005.

Web References:

1. https://writing.wisc.edu/handbook/assignments/planresearchpaper/
2. https://libguides.usc.edu/writingguide/grammar
3. https://grammar.yourdictionary.com/writing/how-to-write-a-research-paper.html
4. https://wordvice.com/seminar-how-to-write-an-effective-research-paper/

Assessment pattern:

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation (Internal)	Assignment 1	1	20	100
	Assignment 2	2	20	
	Assignment 3	3	20	
	MCQ	1,2,3	20	
	Descriptive Pattern Test	1,2,3	20	

- **Students will be finally awarded with three levels based on the score as follows:**

Marks Scored	Levels
70% & above	Good
30- 69%	Average
< 30%	Fair

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SEMESTER I- ELECTIVES

Course Code:19CCEN1101	Course Title: ADVANCED VIBRATIONS AND ACOUSTICS		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the basic technical parameters of acoustics, noise and vibration.
2. Analyze the free and forced vibration of the beam with different end conditions
3. Explain the procedure for vibration measurement technique for a given problem.
4. Explain the effect of the noise, blast, vibration, and shock on people
5. Explain the procedure for noise measurement technique for a given problem.

UNIT I - FUNDAMENTALS OF ACOUSTICS AND NOISE, VIBRATION **10 Hours**

Theory of Sound— Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging of decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis, Sound Sources, Sound Propagation in the Atmosphere, Sound Radiation from Structures.

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and non linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.

UNIT II - VIBRATION OF CONTINUOUS SYSTEM **9 Hours**

Continuous Systems, Natural Vibrations of beams – Differential equation of motion, solution by the method of separation of variables, frequency parameter, natural frequencies and mode shapes, forced vibration of simply supported beam subjected to concentrated harmonic force at a point, Mode summation method, discretized models of continuous systems and their solutions using Rayleigh – Ritz method

UNIT III - VIBRATION MEASUREMENT AND CONTROL TECHNIQUES **8 Hours**

Vibration instruments, Vibration exciters Measuring Devices, Analysers, signal processing; modal parameter identification; time-domain and frequency-domain vibration analysis. Experimental modal analysis. Vibration isolation and absorption; passive and active vibration control.

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UNIT IV -EFFECTS OF NOISE, BLAST, VIBRATION, AND SHOCK ON PEOPLE **9Hours**

General Introduction to Noise and Vibration Effects on People and Hearing Conservation, Sleep Disturbance due to Transportation Noise Exposure, Noise-Induced Annoyance, Effects of Infrasound, Low-Frequency Noise, and Ultrasound on People, Auditory Hazards of Impulse and Impact Noise, Effects of Intense Noise on People and Hearing Loss, Effects of Vibration on People, Effects of Mechanical Shock on People, Rating Measures, Descriptors, Criteria, and Procedures for Determining Human Response to Noise.

UNIT V - ACOUSTIC MEASUREMENT AND NOISE CONTROL TECHNIQUES **9 Hours**

Acoustical Transducer Principles and Types of Microphones, Sound Level Meters, Noise Dosimeters, Analyzers and Signal Generators, Equipment for Data Acquisition.

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basic technical parameters of acoustics, noise and vibration.	Understand
CO2: Analyze the free and forced vibration of the beam with different end conditions	Analyzing
CO3: Explain the procedure for vibration measurement technique for a given problem and suggest suitable control system.	Understand
CO4: Explain the effect of the noise, blast, vibration, and shock on people	Understand
CO5: Select the procedure for noise measurement technique for a given problem and suggest suitable control system.	Apply

Reference Book(s):

R1. Ambekar A.G., Mechanical Vibrations and Noise Engineering; PHI ,2006

R2. Sujatha. C, Vibration and acoustics, measurements and signal analysis,TMH,2010

R3. S. S.Rao, Mechanical Vibrations, Pearson Eduction,2011.

R4. Thomson W.T and Marie Dillon Dahleh ,Theory of Vibration with Applications, CBS Publishers & Distributors / Prentice Hall of India,2003

Web References:

1. https://nptel.ac.in/courses/112103111/
2. https://nptel.ac.in/courses/112103112/

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

Course Code: 19CCEN1102	Course Title: ADVANCED STRENGTH OF MATERIALS		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Solve the stresses, strains and elastic constants of structural member subjected to external loads in three dimensional members.
2. Determine the stresses and deflections in beam structures subjected to unsymmetrical loading.
3. Solve the stresses and strains for thick cylinders and rotating disks such as shafts and cylinders.
4. Determine the torsional stresses for non-circular sections.
5. Solve the stresses in circular and rectangular plates subjected to various types of loads and end conditions of flat plates.

UNIT I - STRESSES, STRAINS AND ELASTICITY

9 Hours

Stress – Strain relation and General equation of elasticity in cartesian, polar and spherical coordinates-differential equation of equilibrium – compact ability – boundary conditions, representations of three dimensional stress of a tension – generalized Hooke's law – St.Vennant's principle – Plane strain, plane stress – Airy's stress function. HearCentre:Location of shear centre for various sections – shear flow.

UNIT II - UNSYMMETRICAL BENDING

9 Hours

Stresses and deflection in beams subjected to unsymmetrical loading – Kern of a section. Curved flexural members - circumferential and radial stresses – deflection and radial curved beam with re-strained ends– closed ring subjected to concentrated load and uniform load – chain link and crane hooks.

UNIT III - THICK CYLINDERS AND ROTATING DISKS

9 Hours

Thick walled cylinder subjected to internal and external pressures – Shrink fit joints – Stresses due to rotation – Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness– allowable speed. – Rotating shafts and cylinders

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UNIT IV -TORSION OF NON CIRCULAR SECTIONS 9Hours

Torsion of rectangular cross section – St.Vennant Theory – elastic membrane analogy – Prandtl's stress function – Torsional stresses in hollow thin walled tubes.

UNIT V - STRESSES IN FLAT PLATES 9 Hours

Stresses in circular and rectangular plates due to various types of loading and end conditions – Buckling of plates. Theory of contact stresses – methods of computing contact stresses – deflection of bodies in point and line contact – applications.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Solve the stresses, strains and elastic constants of structural member subjected to external loads in three dimensional members.	Apply
CO2: Determine the stresses and deflections in beam structures subjected to unsymmetrical loading.	Apply
CO3: Solve the stresses and strains for thick cylinders and rotating disks such as shafts and cylinders.	Apply
CO4: Determine the torsional stresses for non-circular sections.	Apply
CO5: Solve the stresses in circular and rectangular plates subjected to various types of loads and end conditions of flat plates.	Apply

Reference Book(s):

R1. Arthur P.Boresi and Richard J.Schmidt, "Advanced Mechanics of Materials", John, Willey &Sons,Inc., 2003.

R2. Robert, D.Cook, Wareen.C.Yound, "Advanced Mechanics of Materials", MacmillonPublishers Company, 2003.

R3. Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw Hill Publishing Company Limited, 2003.

R4. Craig, R.R. "Mechanics of Materials", John Wiley & Sons,3rd Edition, 2011.

R5. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.

Web References:

1. http://nptel.ac.in/courses/112101095/2
2. https://www.slideshare.net/akhtarkamal94/advanced-strength-of-material

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

Course Code:19CCEN1103	Course Title:COMPUTATIONAL FLUID DYNAMICS		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3:0:0	Credits: 3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the governing equations for fluid flow and the finite difference formulations.
2. Solve the conduction heat transfer using finite difference method.
3. Solve the convection heat transfer using finite difference method.
4. Solve incompressible viscous flow problems.
5. Enable the students to understand the concept of turbulence modeling.

UNIT I - GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCEMETHOD **9 Hours**

Continuity equation, momentum equation, energy equation, classification, initial and boundary conditions, finite difference method -central, forward and backward difference, uniform and non-uniform grids, numerical errors.

UNIT II - CONDUCTION HEAT TRANSFER **9 Hours**

Steady one-dimensional conduction, two and three-dimensional steady state problems, transient one-dimensional problem, two-dimensional transient problems

UNIT III - CONVECTION HEAT TRANSFER **9 Hours**

Steady one-dimensional and two-dimensional convection – diffusion, unsteady one-dimensional convection – diffusion, unsteady two-dimensional convection – diffusion.

UNIT IV -INCOMPRESSIBLE FLUID FLOW **9Hours**

Governing equations, stream function – vorticity method, determination of pressure for viscous flow, SIMPLE procedure of Patankar and Spalding, computation of boundary layer flow.

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UNIT V - TURBULENCE MODELS **9 Hours**

Algebraic models – one equation model, K – Ɛ models, standard and high and low Reynolds number models, prediction of fluid flow and heat transfer using standard codes.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the discretization of governing equations using finite difference method.	Understand
CO2: Solve the conduction heat transfer using finite difference method.	Apply
CO3: Calculate the convection heat transfer using finite difference method.	Apply
CO4: Solve incompressible viscous flow problems using vorticity method and SIMPLE algorithm.	Apply
CO5: Calculate the fluid flow and heat transfer properties using turbulence modeling.	Apply

Reference Book(s):

R1. Anderson D.A., Tannehil J.C, Pletcher R.H, Computational Fluid Mechanics & Heat Transfer, Hemisphere Publiishing Corporation, New York, 2004.

R2. John D. Anderson, Computational Fluid Dynamics: The Basics with Applications, First Edition, McGraw-Hill Education, 2012

R3. Murlidhar.K.,Sunderrajan.T, Computational Fluid Mechanics and Heat Transfer, Narosa Publishing House, 2008.

R4. Klaus A. Hofmann, Steve T. Chiang, Computational Fluid Dynamics, Fourth Edition, Engineering Education System, 2000.

Web References:

1. https://www.cfd-online.com/Links/
2. https://www.simscale.com/forum/t/a-collection-of-cfd-resources/70650

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

Course Code: 19CCEN1104	Course Title: WELDING METALLURGY		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Define the thermal cycles in welding processes.
2. Explain the welding metallurgy of steels.
3. Explain the weldability of steels.
4. Explain the weldability of non-ferrous alloys.
5. Explain the various welding defects with dissimilar welding process.

UNIT I THERMAL CYCLES IN WELDING

9Hours

Heat flow-Basic heat transfer equations, temperature distributions and cooling curves-Influence of heat input, Joint Geometry, plate thickness, preheating and other factors. Comparison of welding processes based on these considerations. Solidification – Epitaxial growth – weld metal solidification – cellular and columnar structures – effect of welding parameters – absorption of gases – gas/metal and slag/metal reactions.

UNIT II WELDING METALLURGY OF STEELS

9Hours

Effects of steel composition on weldability - formation of different microstructural zones in welded plain carbon steels, C-Mn Steels Phase transformation in weld and heat affected zones – formation of acicular ferrite – carbon equivalent – concept of preheating and post heating – considerations governing their choice and applications. Cold cracking – Factors affecting cold cracking- remedies. Hot cracking of steels- Factors affecting hot cracking-remedies. Weldability – Concept, testing methods.

UNIT III WELDABILITY OF STEELS

9 Hours

Weldability of low alloy steels, Steels for low and high temperature use, all types of stainless steels, Cast Irons and selection. Also selection of welding process and procedure appropriate for eachsteel

UNIT IV WELDABILITY OF NON-FERROUS ALLOYS

9Hours

Weldability of aluminum and its alloys, copper and its alloys, Titanium and its alloys Ni and its alloys and Mg and its alloys – Selection of welding process and procedure appropriate for each material.

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UNIT V DISSIMILAR WELDING AND WELDING DEFECTS **9 Hours**

Dissimilar welding: Metallurgical problems in dissimilar welding- calculation of dilution- methods of controlling dilution - techniques of dissimilar welding- welding of various dissimilar metals combinations like steels, cast irons, Al, Cu, Mg, Ni to other alloys.
Welding Defects: Lamellar tearing and reheat cracking. Defects in welded joints: Origin, effects, and remedies. Arc welding defects, resistance welding defects, defects in friction welding, defects in welds of other welding processes.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Define the concepts used in thermal cycles of welding processes.	Understand
CO2: Explain the effects of various alloying additions on the physical metallurgy.	Understand
CO3: Explain the physical and welding metallurgy of steels.	Understand
CO4: Explain the weldability issues associated with the various classes of non-ferrous alloys	Understand
CO5: Explain the weldability issues associated with the welding of dissimilar metals.	Understand

Reference Book(s):

R1. Sindo Kou, "Welding Metallurgy", John Wiley & Sons, 2003.

R2. ASM Metals Hand Book, "Welding, Brazing and Soldering", ASM International, Metals Park, Ohio, USA, 1993.

R3. Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM, 2007

R4. Linnert. G.E. "Welding Metallurgy", Vol. 1 and Vol.2 4th Edition. A W S. 1994.

R5. Easterlin.K.E.,"Introduction of Physical Metallurgy of Welding", 2nd ed. Butterworth Heinmann. 1992

Web References:

1. https://awo.aws.org/online-courses/metallurgy-courses/metallurgy-ii/
2. https://www.twi-global.com/what-we-do/research-and-technology/technologies/materials-and-corrosion-management/welding-metallurgy-and-weldability

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

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CourseCode:19CCEN1105	Course Title: FLEXIBLE COMPETITIVE MANUFACTURING SYSTEM		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the manufacturing techniques in competitive environment.
2. Explain the concepts of group technology in FMS.
3. Explain the Flexible manufacturing systems and its techniques.
4. Explain the software and database related to FMS.
5. Explain the JUST IN TIME concept.

UNIT I - MANUFACTURING IN A COMPETITIVE ENVIRONMENT — 9 Hours

Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible, fixturing - Design for assembly, disassembly and service.

UNIT II - GROUP TECHNOLOGY — 9 Hours

Part families - classification and coding - Production flow analysis - Machine cell design - Benefits.

UNIT III - FLEXIBLE MANUFACTURING SYSTEMS — 9 Hours

Introduction - Components of FMS - Application workstations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

UNIT IV - COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS — 9Hours

System issues - Types of software - specification and selection - Trends - Application of simulation - software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

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UNIT V - JUST IN TIME **9 Hours**

Characteristics of JIT - Pull method - quality -small lot sizes - work station loads - close supplier ties - flexible work force - line flow strategy - preventive maintenance - Kanban system - strategic implications - implementation issues - MRD JIT - Lean manufacture.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1:	Explain the manufacturing techniques in competitive environment for future industries.	Understand
CO2:	Explain the concepts of group technology in FMS for machine cell design.	Understand
CO3:	Explain the Flexible manufacturing systems and its techniques for future industries.	Understand
CO4:	Explain the software and database related to FMS for manufacturing data systems.	Understand
CO5:	Explain the JUST IN TIME concept for effective manufacturing.	Understand

Reference Book(s):

R1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing ", Prentice-Hall of India Pvt. Ltd., New Delhi, 2009.

R2. Jha, N.K. " Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 2000.

R3. Kalpakjian, " Manufacturing Engineering and Technology ",Prentice Hall; 6 edition , 2009

R4. TaiichiOhno, Toyota, " Production System Beyond Large-Scale production", Productivity Press (India) Pvt. Ltd., 1992

Web References:

1. https://nptel.ac.in/courses/112107143/36
2. https://nptel.ac.in/courses/112104228/31
3. https://nptel.ac.in/courses/110106044/28

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Course Code:19CCEN1106	Course Title: PRODUCT DATA MANAGEMENT		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3 : 0 : 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives

The course is intended to:

1. Learn about the components of a typical PDM.
2. Develop the simple projects in life cycle of a product.
3. Study about the Data Management Systems for FEA data.

Unit I - INTRODUCTION **3 Hours**

Introduction to PDM-present market constraints-need for collaboration - internet and developments in server-client computing.

Unit II - COMPONENTS OF PDM **9 Hours**

Components of a typical PDM setup-hardware and software-document management-creation and viewing of documents-creating parts-versions and version control of parts and documents-case studies.

Unit III -CONFIGURATION MANAGEMENT **5 Hours**

Base lines-product structure-configuration management-case studies.

Unit IV -PROJECTS AND ROLES **12Hours**

Creation of projects and roles-life cycle of a product- life cycle management-automating information flow- work flows- creation of work flow templates -life cycle-work flow integration-case studies.

Unit V - CHANGE MANAGEMENT **6 Hours**

Change issue- change request- change investigation- change proposal - change activity – case studies.

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Unit VI - GENERIC PRODUCTS AND VARIANTS **10 Hours**

Data Management Systems for FEA data - Product configurator - comparison between sales configuration and product configurator-generic product modeling in configuration modeler-use of order generator for variant creation-registering of variants in product register-case studies.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Select the components of PDM to develop a model.	Apply
CO2: Develop the simple projects in life cycle of a product.	Apply
CO3: Apply Data Management Systems in FEA data.	Apply

Reference Book(s):

R1. Kevin Otto, Kristin Wood, "Product Design", Pearson, 2017.

R2. David Bed worth. Mark Henderson & Phillip Wolfe. "Computer Integrated Design and Manufacturing ". McGraw Hill Inc...2011.

R3. Terry Quatrain. "Visual Modeling with Rational Rose and UML ".Addison Wesley, 2010.

R4. Wind-Chill RUNIT V0 Reference Manuals, 2010.

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

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Course Code:19CCEN1107	Course Title: PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the concepts of basic productivity.
2. Explain the productivity measurement approaches of the organizations.
3. Explain the principles of organizational transformation and re-engineering.
4. Explain the various process improvement models of reengineering.
5. Explain the various re-engineering tools and techniques for project implementation.

UNIT I PRODUCTIVITY **9Hours**

Productivity Concepts – Macro and Micro factors of productivity – Dynamics of Productivity - Productivity Cycle Productivity Measurement at International, National and Organization level - Productivity measurement models.

UNIT II SYSTEMS APPROACH TO PRODUCTIVITY MEASUREMENT **9Hours**

Conceptual frame work, Management by Objectives (MBO), Performance Objectivated Productivity (POP) – Methodology and application to manufacturing and service sector-Modes of engineering services and manufacturing companies certification.

UNIT III ORGANISATIONAL TRANSFORMATION **9 Hours**

Elements of Organizational Transformation and Reengineering-Principles of organizational transformation and re-engineering, fundamentals of process re-engineering, preparing the workforce for transformation and re-engineering, methodology, guidelines, LMI CIP Model – DSMC Q & PMP model.

UNIT IV RE-ENGINEERING PROCESS IMPROVEMENT MODELS **9Hours**

PMI models, PASIM Model, Moen and Nolan Strategy for process improvement, LMICIP Model, NPRDC Model-Identification of current business processes – establishing the scope of the process –mapping and analyzing the process. Process Creation: Creating the ideal process – testing the new process – implementing the new process. Evaluation: Evaluating the improvement (criteria) of measurements hurdles foreseen in designing and implementing meaningful measures.

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UNIT V RE-ENGINEERING TOOLS AND IMPLEMENTATION 9 Hours

Analytical and process tools and techniques – Information and Communication Technology – Implementation of Reengineering Projects – Success Factors and common implementation Problem – Cases, Reengineering team steering committee and Re-engineering Czar – key points for succeeding at Reengineering – case studies.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1:	Explain the concepts of basic Productivity.	Understand
CO2:	Explain the Productivity Measurement Approaches of the Organizations	Understand
CO3:	Explain the principles of organizational transformation and re-engineering.	Understand
CO4:	Explain the various Process Improvement Models of Reengineering.	Understand
CO5:	Explain the various Re-Engineering Tools and techniques for Project implementation.	Understand

Reference Book(s):

R1. Sumanth, D.J., „Productivity Engineering and Management", TMH, New Delhi, 1990.

R2. Edosomwan, J.A., "Organizational Transformation and Process Re-engineering", Library Cataloging in Pub. Data, 1996

R3. Premvrat, Sardana, G.D. and Sahay, B.S., "Productivity Management – A Systems Approach", Narosa Publishing House. New Delhi, 1998.

R4. MartandTelsang, "Industrial engineering and production management" S chand and company, New Delhi India 5th Edition, 2012.

R5. Michael Hammer, "The Re-engineering Revolution Handbook, "Herper – Collins Publishers,London, UK, 2000.

Web References:

1. https://tallyfy.com/business-process-reengineering/
2. http://web.simmons.edu/~chen/nit/NIT'93/93-193-koen.html
3. https://www.bain.com/insights/management-tools-business-process-reengineering/

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

Course Code: 19CCEN1108	Course Title:CORROSION AND SURFACE ENGINEERING		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the mechanism of corrosion.
2. Explain the various techniques used in Corrosion testing.
3. Explain the concept used in Corrosion Behavior of Materials.
4. Explain the Surface Engineering techniques used in Corrosion resistance.
5. Explain the various protective surface coatings to improve corrosion resistance.

UNIT I MECHANISMS AND TYPES OF CORROSION **9Hours**

Principles of direct and Electro Chemical Corrosion, Hydrogen evolution and Oxygen absorption mechanisms – Galvanic corrosion, Galvanic series-specific types of corrosion such as uniform, Pitting, Intergranular, Cavitations, Crevice Fretting, Erosion and Stress Corrosion – Factors influencing corrosion.

UNIT II TESTING AND PREVENTION OF CORROSION **9Hours**

Corrosion testing techniques and procedures- Prevention of Corrosion-Design against corrosion –Modifications of corrosive environment –Inhibitors – Cathodic Protection –Protective surface coatings.

UNIT III CORROSION BEHAVIOR OF MATERIALS **9 Hours**

Corrosion of steels, stainless steel, Aluminum alloys, copper alloys, Nickel and Titanium alloys-corrosion of Polymers, Ceramics and Composite materials.

UNIT IV SURFACE ENGINEERING FOR WEAR AND CORROSION RESISTANCE **9Hours**

Diffusion coatings –Electro and Electroless Plating –Hot dip coating –Hard facing-Metal spraying, Flame and Arc processes- Conversion coating –Selection of coating for wear and Corrosion resistance.

UNIT V THIN LAYER ENGINEERING PROCESSES **9 Hours**

Laser and Electron Beam hardening –Effect of process variables such as power and scan speed - Physical vapor deposition, Thermal evaporation, Arc vaporization, Sputtering, Ion plating - Chemical vapor deposition – Coating of tools, TiC, TiN, Al2O3 and Diamond coating – Properties and applications of thin coatings.

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the mechanism of corrosion.	Understand
CO2: Explain the various techniques used in Corrosion testing.	Understand
CO3: Explain the concept used in Corrosion Behavior Of Materials.	Understand
CO4: Explain the Surface Engineering techniques used in Corrosion resistance.	Understand
CO5: Explain the various protective surface coatings to improve corrosion resistance.	Understand

Reference Book(s):

R1. Fontana. G., "Corrosion Engineering", McGraw Hill, 2008.

R2. Schweitzer. P.A., "Corrosion Engineering Hand Book", 3rd Edition, Marcel Decker, 2008.

R3. Kenneth G.Budinski, "Surface Engineering for Wear Resistance", Prentice hall, 2011.

R4. SM Metals Hand Book –Vol. 5, "Surface Engineering", 2010.

R5. Winston Revie.R. Uhlig, Corrosion, Hand Book 2nd edition. John Wiley, 2008.

Web References:

1. https://www.researchgate.net/publication/284924836_Materials_characterization_and_the_
2. http://www.vssut.ac.in/lecture-notes.php?url=metallurgy-materials-engineering

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SEMESTER II

Course Code:19CCCN1201	Course Title:FINITE ELEMENT METHOD		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives

The course is intended to:

1. Comprehend the methodology & numerical basis behind FEA.
2. Solve 1D & 2D linear static problems encountered in various applications.
3. Solve problems involving isoparametric elements and higher-order elements.
4. Solve linear dynamic problems for various applications.
5. Solve non-linear problems for various applications using Newton-Raphson methods, Incremental Secant method, and Incremental Force method.

UNIT I - INTRODUCTION TO FEA

10 Hours

Need for FEA & its relevance in problem-solving; FEA rationale & methodology; Types of problems – linear, non-linear, time dependence, initial value, boundary value; Coordinate systems (local and global); Theory of Elasticity; Fundamental governing equations in linear static analysis;Stiffness matrix; Jacobean; Shape Functions;Galerkin's, Weighted Residual, Virtual Work, Virtual Displacement& Potential Energy methods.

UNIT II - 1D & 2D LINEAR STATIC PROBLEMS

9 Hours

1D & 2D linear static problems in structural mechanics & heat transfer; Bar element; Beam element; Plate element; Shell element; 2D Frame (Truss) element; Linear Triangular (CST) elements; Plane Stress & Plane Strain problems; Structural problems – involving axial, bending, bearing, torsion, shear loadings; Heat transfer problems – involving conduction, convection& radiation heat transfer.

UNIT III - ISOPARAMETRIC ELEMENTS, HIGHER ORDER ELEMENTS &3D LINEAR STATIC PROBLEMS

9 Hours

Legendre Polynomials; Numerical integration methods; Gauss Quadrature Rule; Newton-Cotes Rule; Simpson's Rule; Trapezium Rule; Isoparametric elements; Higher order elements; Axisymmetric elements; 3D linear static problems & elements; 3D Space Frame (Truss) element; Quadratic elements; Tetrahedron elements; Hexahedral elements.

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UNIT IV - LINEAR DYNAMIC PROBLEMS **9 Hours**

Linear dynamic problems in structural mechanics & heat transfer; Hamilton's Principle; Fundamental governing equations in linéar dynamic analysis; Mass matrix; Damping matrix; Natural frequencies & modes; Variational (Rayleigh-Ritz) Method; Eigen value problems; Explicit &implicit methods for time-dependent analysis; Harmonic response analysis; Response-spectrum analysis; Component Mode Synthesis (CMS) / Dynamic Substructuring.

UNIT V - NON-LINEAR PROBLEMS, ERROR NORMS & CONVERGENCE **8 Hours**

Theory of Plasticity; Elasticity, elastoplasticity& plasticity; Viscoplasticity; Types of non-linearity (geometric, material & contact); Newton-Raphson Methods (Regular & Modified); Incremental Secant Method; Incremental Force Method; Large strain & large displacement problems; Iterative procedures in non-linear analysis; Error norms vs element size (computed vs analytical/experimental values); Convergence criteria; Convergence ratesfor error norms; Mesh refinement (h-refinement, p-refinement& adaptive meshing).

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Comprehend the methodology & numerical basis behind FEA.	Understand
CO2: Solve 1D & 2D linear static problems encountered in various applications.	Apply
CO3: Solve problems involving isoparametric elements and higher-order elements.	Apply
CO4: Solve linear dynamic problems for various applications.	Apply
CO5: Solve non-linear problems for various applications using Newton-Raphson methods, Incremental Secant method, and Incremental Force method.	Apply

Reference Book(s):

R1. Cook, Robert Davis et al "Concepts and Applications of Finite Element Analysis", Wiley, John & Sons, 2007.

R2. Logan D.L, "A First Course in the Finite Element Method", Fifth Edition, Thomson Learning, 2012

R3. Segerlind L.J., "Applied Finite Element Analysis", John Wiley, 1999

R4. Bathe, Klaus-Jürgen, "Finite Element Procedures", Second Edition, Prentice Hall Pearson Education Inc., 2016

R5. Reddy J.N., "An Introduction to the Finite Element Method", McGraw Hill, International Edition, 2005.

R6. Hughes, Thomas J.R., "The Finite Element Method: Linear Static and Dynamic Finite Element Analysis", First Edition, 2000.

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Web References:

1. http://www2.mae.ufl.edu/nkim/egm6352/Chap2.pdf
2. https://nptel.ac.in/courses/105108072/mod07/hyperlink-4.pdf
3. http://web.mae.ufl.edu/nkim/book.html

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Course Code:19CCCN1202	Course Title:APPLIED MATERIALS ENGINEERING		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the elastic, plastic behaviours of different materials
2. Explain the acceptable level of risk for a particular component.
3. Select a suitable material
4. Explain the properties of modern metallic materials
5. Explain the properties of non metallic materials

UNIT I - ELASTIC AND PLASTIC BEHAVIOUR **10 Hours**

Elasticity in metals and polymers - Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanisms, work hardening, solid solution strengthening, grain boundary strengthening, poly phase mixture, precipitation, particle, fiber and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviors - Super plasticity - Deformation of non-crystalline material.

Unit II - FRACTURE BEHAVIOUR **10 Hours**

Griffith theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Larson-Miller parameter - Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue - Fracture of non metallic materials - Failure analysis, sources of failure, procedure of failure analysis.

Unit III - SELECTION OF MATERIAL **10 Hours**

Motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance Relationship between materials selection and processing - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

Unit IV -MODERN METALLIC MATERIALS **7 Hours**

Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nano crystalline materials.

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Unit V - NON METALLIC MATERIALS **8 Hours**

Polymeric materials - Formation of polymer structure - Production techniques of fibers, foams, adhesives and coatings - Structure, properties and applications of engineering polymers - Advanced structural ceramics, WC, TiC, TaC, Al2O3, SiC, Si3N4, CBN and diamond - properties, processing and applications.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1:	Explain the elastic, plastic behaviours of different materials and to utilize basic properties of materials to solve problems related to isotropic elasticity	Understand
CO2:	Explain the acceptable level of risk for a particular component or application subjected to fracture, fatigue and the relation with its microscopic mechanism of deformation.	Understand
CO3:	Select a suitable material to meet the design specification by evaluating the relationship between material properties, microstructures and processing.	Apply
CO4:	Explain the properties of modern metallic materials and its need for the emerging engineering application.	Understand
CO5:	Explain the properties of non-metallic materials used for a specific engineering application	Understand

Reference Book(s):

R1. Flinn, R.A. and Trojan, P.K., "Engineering Materials and their Applications ", (7th Edition), Jaico, 2002.

R2. George E.Dieter, "Mechanical Metallurgy ", McGraw Hill, 3rd edition 2017.

R3. Thomas H.Courtney, "Mechanical Behaviour of Materials ", (2nd Edition), McGraw-Hill, 2000

R4. Charles J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of Engineering Materials ", (3rd Edition), Butterworth-Heiremann, 1997.

Web References:

1. https://www.nature.com/articles/061199b0
2. https://www.asminternational.org/search/-

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

Course Code:19CCCN1203	Course Title: INTEGRATED PRODUCT AND PROCESSES DEVELOPMENT		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain product development process.
2. Discuss product planning process.
3. Explain product specifications.
4. Analyze the concept selection and concept testing.
5. Explain product architecture.

UNIT I - INTRODUCTION

9 Hours

Characteristics of Successful Product Development-Interdisciplinary activity-Duration and Costs of Product Development- Challenges of Product Development -Development Processes and Organizations-A Generic Development Process-Concept Development: The Front-End Process Adapting the Generic Product Development Process- The AMF Development Process-Product Development Organizations-The AMF Organization.

UNIT II - PRODUCT PLANNING

9 Hours

Product Planning Process- Identifying Opportunities- Evaluating and Prioritizing Projects-Allocating Resources and Timing- Pre-Project Planning-Reflect on the Results and the Process-Identifying Customer Needs- Raw Data from Customers- Interpreting Raw Data in Terms of Customer Needs-Organizing the Needs into a Hierarchy-Establishing the Relative Importance of the Needs-Reflecting on the Results and the Process.

UNIT III - PRODUCT SPECIFICATIONS

9 Hours

Specifications - Specifications Established - Establishing Target Specifications-Setting the Final Specifications-Concept Generation-The Activity of Concept Generation-Clarify the Problem-Search Externally-Search Internally-Explore Systematically- Reflect on the Results and the Process.

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UNIT IV -CONCEPT SELECTION

9Hours

Concept Selection- Overview of Methodology-Concept Screening-Concept Testing-Define the Purpose of the Concept Test- Choose a Survey Population- Choose a Survey Format-Communicate the Concept-Measure Customer Response-Interpret the Results- Reflect on the Results and the Process.

UNIT V - PRODUCT ARCHITECTURE

9 Hours

Product Architecture-Implications of the Architecture-Establishing the Architecture-Delayed Differentiation-Platform Planning-Related System-Level Design Issues.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the product development process in various organizations.	Understand
CO2: Discuss product planning process and identify customer needs.	Understand
CO3: Explain product specifications and concept generation in product planning.	Understand
CO4: Examine the concept selection and concept testing for various products.	Analyze
CO5: Explain various product architectures and address design level issues.	Understand

Reference Book(s):

R1. Product Design and Development, Karl T. Ulrich and Steven .D Epinger , McGraw-Hill International Edn 2015.

R2. Kevin Otto and Kristin Wood, "Product Design" Pearson Publication, 2011.

R3. Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh, Addison Wesley Publishing, New york, NY, 2014, ISBN 0-202-41639-5.

R4. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 2014, ISBN, 1-55623-603-4.

R5. Concurrent Engg. /Integrated Product Development. Kenneth Crow, DRM Associates, 26/3,ViaOlivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book, 2013.

Web References:

1. http://www.npd-solutions.com/ippdtenets.html
2. https://www.pmi.org/learning/library/modeling-ippd-design-team-8530
3. https://simple-pdh.com/principles-of-integrated-product-development/

Passed in Board of Studies meeting held on 02.04.19

Approved in Academic Council meeting held on 27.07.19

BOS Convener

BOS Chairman

Course Code:19CCCN2201	Course Title: CAE LABORATORY		
Course Category: Professional Core		Course Level: Practice	
L:T:P: 0: 0: 4	Credits:2	Total Contact Hours:60	Max Marks:100

Course Objectives

The course is intended to:

1. Explain software tools needed to analyze engineering problems.
2. Apply finite element simulation software.
3. Solve different engineering application problem using simulation and analysis tools.

AREA OF EXPERIMENTS:

Analysis

1. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
2. Stress analysis of a plate with a circular hole.
3. Stress analysis of Axi – symmetrical element.
4. Vibration analysis of spring-mass systems.
5. Harmonic, transient and spectrum analysis of simple systems.
6. Mode frequency analysis of beams(Cantilever, Simply supported, Fixed ends)
7. Thermal stress analysis of a 2D component
8. Thermal stress analysis of cylindrical shells

Simulation

9. Solve simple vibration problems using MATLab.
10. Mechanism simulation using Multi-body Dynamics software.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Solve structural, thermal and vibration problems in mechanical engineering using finite element simulation software	Apply
CO2: Construct engineering model, analyze and simulate experiments to meet real world engineering system.	Apply

Reference (s):

R1. DivyaZindani, Apurba Kumar Roy, Kaushik Kumar," Working with ANSYS: A Tutorial Approach", I K International Publishing House Pvt. Ltd,2017

R2. CAE Laboratory manual

Passed in Board of Studies meeting held on 02.04.19

BOS Member

Approved in Academic Council meeting held on 27.07.19

BOS Chairman

Course Code:19SHAG1201	Course Title: TEACHING AND LEARNING IN ENGINEERING (common to all PG Programmes)	
Course Category: Humanities	Course Level: Introductory	
L:T:P: 2:0:0	Total Contact Hours: 30	Max Marks:100

Course Objectives

The course is intended to:

1. Use Outcome based approach in teaching courses.
2. Conduct lecture/practical/tutorial sessions using active learning methods.
3. Conduct higher order assessments using rubrics.

UNIT I - OUTCOME BASED APPROACH **10 Hours**

Outcome based Education- Need & Approach- Washington accord- Graduate attributes- Learning outcomes –Blooms Taxonomy

UNIT II - ACTIVE LEARNING METHODS **10 Hours**

Design and Delivery plan for lectures/practical/tutorial sessions-Need for Active learning methods-Active learning strategies- Benefits of Active learning Methods

UNIT III-ASSESSMENTS **10 Hours**

Assessments- types of assessments-need for rubrics, Types of rubrics- Assessment using rubrics

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Use outcome based approach in teaching courses in engineering programmes.	Apply
CO 2: Conduct lecture/practical/tutorial sessions using active learning methods.	Apply
CO 3: Conduct higher order assessments using rubrics.	Apply

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Reference Book(s):

R1. William G. Spady and Francis Aldrine A. Uy (2014). Outcome-Based Education: Critical Issues and Answers, ISBN: 978-971-0167-41-8, Maxcor Publishing House, Inc.

R2. Dr. William G. Spady, WajidHussain, Joan Largo, Dr. Francis Uy (2018). Beyond Outcomes Accreditation: Exploring the Power of 'Real' OBE Practices.

R3. Richard M. Felder, Rebecca Brent (2016), Teaching and Learning STEM: A Practical Guide, John Wiley & Sons Inc

Web References:

1. cid.buu.ac.th/information/Eric_Soulsby_Assessment_Notes.pdf
2. www4.ncsu.edu/unity/lockers/users/f/felder/public/.../Active/Active-learning.pdf
3. https://tomprof.stanford.edu/posting/1491-Common Active Learning Mistakes

Assessment pattern:

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation (Internal)	Assignment 1	1	20	100
	Assignment 2	2	20	
	Assignment 3	3	20	
	MCQ	1,2,3	20	
	Descriptive Pattern Test	1,2,3	20	

- **Students will be finally awarded with three levels based on the score as follows:**

Marks Scored	Levels
70% & above	Good
30- 69%	Average
< 30%	Fair

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SEMESTER II - ELECTIVES

Course Code:19CCEN1201	Course Title: INDUSTRIAL ROBOTICS AND ARTIFICIAL INTELLIGENCE		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the fundamentals of robots.
2. Describe the working of robot drive systems
3. Discuss the working principle of sensors.
4. Explain the implementation of robots
5. Explain the concepts of robot programming.

UNIT I - INTRODUCTION AND ROBOT KINEMATICS **10 Hours**

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – Classifications of Robots. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II - ROBOT DRIVES AND CONTROL **9 Hours**

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT III - ROBOT SENSORS **9 Hours**

Transducers and Sensors – Sensors in Robot – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Gribbing – Image processing and analysis – Image segmentation – Pattern recognition – Training of vision system.

UNIT IV -ROBOT CELL DESIGN & PROGRAMMING **9Hours**

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis - Industrial application of robots. Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation.

UNIT V - ARTIFICIAL INTELLIGENCE AND EXPORT SYSTEMS **8 Hours**

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Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of Artificial Intelligence in Robots

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the fundamentals robot kinematics for forward and reverse motion.	Understand
CO2: Describe the working of robot drive systems for position, Velocity and end effectors.	Understand
CO3: Discuss the working principle of position, force, tactile and image sensors used in robots.	Understand
CO4: Explain the implementation of robotics in industries.	Understand
CO5: Explain the concepts of robot programming with Artificial intelligence.	Understand

Reference Book(s):

R1. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", McGraw-Hill, Int. 2014

R3. Timothy Jordanides et al ,"Expert Systems and Robotics " Springer –Verlag,New York, May 1991.

R4. Fu. K.S., Gonzalez. R.C. and Lee. C.S.G., "Robotics Control, Sensing, Vision and Intelligence",McGraw Hill, 1987.

R5. YoramKoren," Robotics for Engineers' McGraw-Hill, 1985.

Passed in Board of Studies meeting held on 02.04.19

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Course Code:19CCEN1202	Course Title: ADDITIVE MANUFACTURING		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the principle, methods, possibilities and limitations as well as environmental effect
2. Design a component based on additive manufacturing environment
3. Know about the different materials used for additive manufacturing systems

UNIT I - INTRODUCTION **9 Hours**

Overview – Need - Development of Additive Manufacturing Technology -Principle –AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications-Benefits –Case studies.

UNIT II - DESIGN FOR ADDITIVE MANUFACTURING **9 Hours**

Design tools: Data processing - CAD model preparation – Part orientation and support structure generation – Model slicing –Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities – DFAM for part quality improvement-Customised design and fabrication for medical applications.

UNIT III - PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES **9 Hours**

Photo polymerization: SLA-Photo curable materials – Process - Advantages and Applications. Powder Bed Fusion: SLS-Process description – powder fusion mechanism – Process Parameters – Typical Materials and Application. Electron Beam Melting. Case studies

UNIT IV -EXTRUSION BASED AND SHEET LAMINATION PROCESSES **9Hours**

Extrusion Based System: FDM-Introduction – Basic Principle – Materials – Applications and Limitations – Bioextrusion. Sheet Lamination Process: LOM- Gluing or Adhesive bonding – Thermal bonding. Case studies

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UNIT V - PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES 9 Hours

Droplet formation technologies – Continuous mode – Drop on Demand mode – Three Dimensional Printing – Advantages – Bioplotter - Beam Deposition Process: LENS- Process description – Material delivery Process parameters – Materials – Benefits – Applications.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the need of Additive Manufacturing for new product development such as automotive, aerospace, defense, architecture and medical applications.	Understand
CO2: Select a suitable sequence and appropriate design for additive manufacturing based on the intricate design.	Apply
CO3: Explain the photopolymerization and powder bed fusion processes for a given applications such as automotive, aerospace, defense, architecture and medical applications.	Understand
CO4: Explain the extrusion based and sheet lamination processes for a given applications such as automotive, aerospace, defense, architecture and medical applications.	Understand
CO5: Explain the printing processes and beam deposition processes for a given applications such as automotive, aerospace, defense, architecture and medical applications.	Understand

Reference Book(s):

R1. Ian Gibson, David W.Rosen, Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer , 2010.

R2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third edition, World Scientific Publishers, 2010.

R3. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications :A tool box for prototype development", CRC Press, 2007.

R4. Wimpenny, David Ian, Pulak M. Pandey, and L. Jyothish Kumar, eds. Advances in 3D printing & additive manufacturing technologies. Springer Singapore, 2017.

Web References:

1. https://additivemanufacturing.mit.edu

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

Course Code:19CCEN1203	Course Title:METROLOGY AND NON DESTRUCTIVE TESTING		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3 : 0 : 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the purpose of mechanical measuring machines
2. Explain the purpose and need for statistical quality control
3. Explain the process of liquid penetrant and magnetic particle testing
4. Explain the radiographic technique
5. Explain the Ultrasonic and Acoustic Emission method

UNIT I - MEASURING MACHINES **9 Hours**

Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Image shearing microscope - Use of computers - Machine vision technology - Microprocessors in metrology

UNIT II - STATISTICAL QUALITY CONTROL **9 Hours**

Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Reliability and life testing.

UNIT III - LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS **9 Hours**

Characteristics of liquid penetrants - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations.

UNIT IV -RADIOGRAPHY **9Hours**

Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications.

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UNIT V - ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES **9 Hours**

Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Compare the critical engineering parameters measured by the measuring instruments to describe the condition of the working machinery or a part.	Analyze
CO2: Explain the statistical quality control tools and techniques to ensure the quality in the product to meet the design specification	Understand
CO3: Identify the surface flaws in all porous materials using the process of liquid penetrant and magnetic particle testing.	Apply
CO4: Identify the internal defectsutilizing either X-rays or gamma rays to verify the internal structure and integrity of the specimen.	Apply
CO5: Explain the Ultrasonic and Acoustic Emission method of non destructive testing using different scan techniques to identify the defect in the product manufactured.	Understand

Reference Book(s):

R1. Jain, R.K. "Engineering Metrology ", Khanna Publishers, 2009, ISBN: 978-81-7409-153-X.

R2. American Society for Metals, " Metals Hand Book ", Vol.II, 1988

R3. Progress in Acoustic Emission, "Proceedings of 10th International Acoustic Emission Symposium ", Japanese Society for NDI, 1990.

R4. Barry Hull and Vernon John, " Non Destructive Testing ", MacMillan, 1988.

Web References:

1. https://www.ndt.net/publicat/books/books.htm
2. https://www.sciencedirect.com/science/article/pii/B9780750671231500284

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BOS Convener BOS Chairman

Course Code: 19CCEN1204	Course Title: RELIABILITY AND QUALITY ENGINEERING		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Define the concepts used in Quality control system
2. Explain the techniques used in Statistical Process Control.
3. Explain the techniques used in Design of Experiments.
4. Explain the concepts used in Reliability and Quality Management.
5. Explain the various Dynamic tests used in Material Testing.

UNIT-I QUALITY CONCEPTS

9Hours

Quality objectives - Quality control - Quality Assurance - Quality systems, economics, Statistical tolerance - Quality loss functions,Quality as Wining Strategy, Views of different Quality Gurus.

UNIT - II STATISTICAL PROCESS CONTROL

9Hours

Methods and philosophy of statistical process control -Process variability - Chance and assignable causes of quality variation, statistical basis of control charts, control charts for variables, control charts for attributes.

UNIT - III DESIGN OF EXPERIMENTS

9 Hours

Factorial experiments - fractional replication - Taguchi methods - Use of orthogonal arrays – Response surface methodology- Cases.

UNIT - IV RELIABILITY AND QUALITY MANAGEMENT

9Hours

Reliability function – failure rate – mean time between failures (MTBF) – mean time to failure (MTTF) – A priori and a posteriori concept - mortality curve – useful life – availability – maintainability – system effectiveness Reliability prediction and testing - Quality circles - Zero defects program - ISO 9000 and TQM - Total quality organization.

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UNIT -V RELIABILITY MANAGEMENT AND RISK ASSESSMENT **9 Hours**

Reliability testing – Reliability growth monitoring – Non-parametric methods – Reliability and life cycle costs – Reliability allocation – Replacement model-Definition and measurement of risk – risk analysis techniques – risk reduction resources – industrial safety and risk assessment.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Define the concepts used in Quality control system	Understand
CO2: Explain the techniques used in Statistical Process Control.	Understand
CO3: Explain the techniques used in Design of Experiments.	Understand
CO4: Explain the concepts used in Reliability and Quality Management.	Understand
CO5: Explain the various Dynamic tests used in Material Testing.	Understand

Reference Books:

R1. Dale H.Besterfield, "Quality Improvement", PHI, 2010

R2. Douglas, C.Montgomery, "Introduction to Statistical quality control", Second Edition John Wiley &Sons,2009

R3. Srinath L.S, "Reliability Engineering", Affiliated East-West Press Pvt Ltd, New Delhi,2005

R4. Charles E Ebeling, "An Introduction to Reliability and Maintainability Engineering". Tata McGraw-Hill, New Delhi 2009.

R5. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.

Web References:

1. https://onlinelibrary.wiley.com/journal/10991638
2. https://www.worldscientific.com/worldscibooks/10.1142/4346

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

Course Code:19CCEN1205	Course Title:DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the design principles for manufacturability
2. Describe the factors influencing form design
3. Explain the machining consideration while design
4. Optimize the given casting part.
5. Explain the environmental consideration in design.

UNIT I - INTRODUCTION

8 Hours

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks

UNIT II - FACTORS INFLUENCING FORM DESIGN

10 Hours

Influence of materials on form design - form design of grey iron, malleable iron, steel and aluminium castings - form design of welded members, forgings.

UNIT III - COMPONENT DESIGN - MACHINING CONSIDERATION

9 Hours

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

UNIT IV -COMPONENT DESIGN-CASTING CONSIDERATION

9Hours

Redesign of castings based on parting line considerations, minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of un economical design-Modifying the design-group technology-Computer applications of DFMA.

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UNIT V - DESIGN FOR THE ENVIRONMENT

9 Hours

Introduction – Environmental OBJECTIVESS: – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the design principles for manufacturability considering strength, process capability and tolerances.	Understand
CO2: Describe the factors influencing form design of castings, forgings and welding.	Understand
CO3: Explain the machining consideration while design such as machinability, economy, clampability, accessibility and assembly.	Understand
CO4: Improve the given casting part by applying design principles.	Create
CO5: Explain the environmental consideration in design while using DFMA tools.	Understand

Reference Book(s):

R1. Boothroyd, G, Design for Assembly Automation and Product Design, Marcel Dekker, New York., 2010.

R2. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight , "Product Design for Manufacture and Assembly", Third Edition, CRC Press, 2010

R3. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994

R4. Dickson, John. R, and Corroda Poly, "Engineering Design and Design for Manufacture and Structural Approach", Field Stone Publisher, USA, 1999.

Web References:

1. www.codex.cs.yale.edu/avi/db-book/db6 -Jan 23, 2018
2. www.db-book.com- Jan 23, 2018
3. http://highered.mheducation.com/sites/0073523321- Jan 23, 2018

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

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Course Code:19CCEN1206	Course Title: COMPUTER AIDED PROCESS PLANNING		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explains process planning and product planning and GT.
2. Explain geometric modeling techniques, tolerance, and GT.
3. Choose suitable process planning technique for the given part.
4. Explain different computer aided process planning systems.
5. Explain integrated process planning system, selection process, and report generation.

UNIT I - INTRODUCTION **9 Hours**

Introduction to Process Planning and Production Planning – Process Planning in the Manufacturing cycle - Process Planning and Concurrent Engineering, CAPP, Group Technology.

UNIT II - PART DESIGN REPRESENTATION **9 Hours**

Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input / output devices - topology - Geometric transformation - Perspective transformation - Data structure - Geometric modeling for process planning - GT layout, GT- coding - The optiz system - The MICLASS system-CODE system.

UNIT III - PROCESS ENGINEERING AND PROCESS PLANNING **9 Hours**

Experienced, based planning - Decision table and decision trees - Process capability analysis – Process boundaries – Process parameters – Process optimization. Process Planning - Variant process planning - Generative approach - Forward and Backward planning, Input format, AI.

UNIT IV -COMPUTER AIDED PROCESS PLANNING SYSTEMS **9Hours**

Logical Design of a Process Planning - Implementation considerations -manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

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UNIT V - AN INTEGRATED PROCESS PLANNING SYSTEMS **9 Hours**

Totally integrated process planning systems - An Overview – TIPPS Design philosophy- CAD Interface, Modulus structure – Interactive surface identification, Process knowledge-Description language - Data Structure, operation - Input and Display of CAD model- surface identification - select process- select process parameters- Report Generation- Testing results, Expert process planning.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explains process planning, product planning and Group technology for manufacturing process.	Understand
CO2: Explain part design representation and Group technology coding system for part design	Understand
CO3: Choose suitable process planning technique for the given part	Evaluate
CO4: Explain different computer aided process planning such as CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP for manufacturing a part.	Understand
CO5: Explain integrated process planning system, selection process, and report generation for manufacturing a part.	Understand

Reference Book(s):

R1. Gideon Halevi and Roland D. Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1997

R2. Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985

R3. Chang, T.C., " An Expert Process Planning System ", Prentice Hall, 1990

R4. Nanua Singh, "Systems Approach to Computer Integrated Design and Manufacturing ", John Wiley & Sons, 1996.

R5. Rao,P.N " Computer Aided Manufacturing ", Tata McGraw Hill,Publishing Co., 2001

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

Course Code:19CCEN1207	Course Title:MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3 : 0 : 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the fundamentals of automation in material handling
2. Explain the types and principles of manufacturing systems
3. Explain the concepts and components of manufacturing supporting system
4. Explain key management interfaces and activities
5. Explain the various optimized production techniques

UNIT I - MANUFACTURING SYSTEMS AND MODELS

9 Hours

Types and principles of manufacturing systems, types and uses of manufacturing models, physical models, mathematical models, model use, model building.

UNIT II - MATERIAL FLOW SYSTEMS

9 Hours

Assembly lines - Reliable serial systems, approaches to line balancing, sequencing mixed models. Transfer lines and general serial systems-paced lines without buffers, unpaced lines. Shop scheduling with many products. Group technology-assigning machines to groups, assigning parts to machines.

UNIT III - SUPPORTING COMPONENTS

9 Hours

Machine setup and operation sequencing - integrated assignment and sequencing. Material handling systems - conveyor analysis, AGV systems. Warehousing - storage and retrieval systems, order picking.

UNIT IV -GENERIC MODELING APPROACHES

9Hours

Analytical queuing models, a single workstation, open networks, closed networks. Empirical simulation models - even models, process models, simulation system, example manufacturing system.

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UNIT V - SYNCHRONIZATION MANUFACTURING **9 Hours**

Synchronization Vs Optimization, defining the structure, identifying the constraint, exploitation, buffer management.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1:	Explain the principles of manufacturing systems models and its typesfor system modelling.	Understand
CO2:	Select an appropriate material flow system based on system model.	Apply
CO3:	Select appropriate material handling equipment for supporting components.	Apply
CO4:	Choose various Generic Modeling Approaches in the manufacturing system based on size.	Apply
CO5:	Select the process of Synchronization Manufacturingfor supportingcomponents.	Apply

Reference Book(s):

R1. Ronald G Askin, "Modeling and Analysis of Manufacturing Systems", John Wiley and Sons, Inc, 2016.

R2. Brandimarte. P, Villa. A, "Modeling Manufacturing Systems" Springer Verlag, Berlin, 2014.

R3. Mengchu Zhou, "Modeling, Simulation, and Control of Flexible Manufacturing Systems: A Petri Net Approach",Worls Scientific Publishing Company Pvt Ltd. 2010.

R4. Jean Marie ProthandXiaolanXie, "Petri Nets: A Tool for Design and Management of Manufacturing Systems" John Wiley and Sons, New York, 2016.

Web References:

1. http://nptel.ac.in
2. https://mit.edu/courses/mechanical-engineering

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

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Course Code:19CCEN1208	Course Title:DESIGN AND ANALYSIS OF THERMAL SYSTEMS		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits: 3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the working of supervised learning systems.
2. Apply parametric and non-parametric techniques.
3. Develop multilayer perceptron networks.
4. Apply neural network and deep learning algorithms.
5. Evaluate the performance of classifiers and combine multiple learners.

UNIT I - INTRODUCTION **9 Hours**

Design Principles, workable systems, optimal systems, matching of system components, economic analysis , depreciation, gradient present worth factor.

UNIT II - MATHEMATICAL MODELING **9 Hours**

Equation fitting, nomography, empirical equation, regression analysis, different modes of mathematical models, selection, computer programmes for models.

UNIT III - MODELLING THERMAL EQUIPMENTS **9 Hours**

Modelling heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps, simulation studies, information flow diagram, solution procedures.

UNIT IV -SYSTEMS OPTIMIZATION **9Hours**

OBJECTIVES function formulation, constraint equations, mathematical formulation, Calculas method, dynamic programming, geometric programming, linear programming methods, solution procedures

UNIT V - DYNAMIC BEHAVIOUR OF THERMAL SYSTEM **9 Hours**

Steady state simulation, Laplace transformation, feedback control loops, stability analysis, non-linearties.

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the design principles of workable and optimal systems	Understand
CO2: Solve the mathematical modeling of thermal systems by using empirical equation and regression analysis.	Apply
CO3: Solve the modeling of thermal equipments by simulation studies.	Apply
CO4: Apply optimization techniques to solve the objective function of the thermal system	Apply
CO5: Solve the dynamic behavior of thermal system by simulation.	Apply

Reference Book(s)

R1. Stoecker W F, "Design of Thermal Systems"' McGraw Hill, 2011.

R2. Kapur J N, "Mathematical Modelling"' 2nd Edition, New Age International Pvt Ltd Publishers, 2015.

R3. Fanger P O, "Thermal Comport" McGraw Hill, USA 1973.

R4. McQuiston F C and Parker T D, " Heating, Ventilating and Air conditioning, Analysis and design"' 6th Edition, John Wiley and Sons Pvt Ltd , 2011.

Web References:

1. https://onlinecourses.nptel.ac.in/noc17_cs26
2. http://www.ics.uci.edu/mlearn/MLRepository.html
3. https://www.kaggle.com/kanncaa1/machine-learning-tutorial-for-beginners

Passed in BOS meeting held on 02.04.19 Approved in AC 10th meeting held on 27.07.19

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BOS Chairman

Course Code:19CCEN1209	Course Title: EXPERIMENTAL METHODS AND ANALYSIS		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Impart the basics on Experimental methods.
2. Explain the experimental data analysis.
3. Explain the concepts of Temperature measurement
4. Explain the Thermal and transport property measurements
5. Explain the data acquisition and processing

UNIT I - INTRODUCTION –BASIC CONCEPTS — 9 Hours

Introduction – Definition of Terms – Calibration- Standards – Dimension and Units- The Generalized Measurements System- Basic concepts in Dynamic Measurements – System Response- Distortion- Impedance Matching- Experiment Planning.

UNIT II - ANALYSIS OF EXPERIMENTAL DATA — 9 Hours

Introduction – Causes And Types of Experimental Errors- Error Analysis on A Commonsense Basis – Uncertainty Analysis- Evaluation of Uncertainties For A Complicated Data Reduction- Statistical Analysis of Experimental Data – Probability Distributions- The Gaussian Or Normal Error Distribution-Comparison of Data With Normal Distribution-The Chi-Square Test of Goodness of Fit- Method of Least Squares – The Correlation Coefficient- Multivariable Regression- Standard Deviation of The Mean- Students-T- Distribution-Graphical Analysis And Curve Fitting-Choice of Graph Formats-General Consideration in Data Analysis.

UNIT III - THE MEASUREMENT OF TEMPERATURE — 9 Hours

Introduction Temperature Scales-The Ideal- Gas Thermometer-Temperature Measurements by Mechanical Effects- Temperature Measurements By Electrical Effects- Temperature Measurements By Radiation- Effect of Heat Transfer on Temperature Measurements – Transient Response of Thermal System- Thermocouple Compensation. Temperature Measurement in High speed flow.

UNIT IV - THERMAL AND TRANSPORT- PROPERTY MEASUREMENTS — 9 Hours

Introduction-Thermal Conductivity Measurements-Thermal Conductivity of Liquids and Gases-Measurements of Viscosity-Gas Diffusion-Calorimetry-Convection Heat-Transfer-Measurements-Heat-Flux Meters-Ph Measurements.

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UNIT V - DATA ACQUISITION AND PROCESSING

9 Hours

Introduction- The General Data Acquisition System- Signal Conditioning Revisited-Data Transmission-Analog-To-Digital And Digital-To-Analog Conversion-Data Storage And Display-The Program as A Substitute For Wired Logic.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Explain the basics on Experimental methods.	Understand
CO 2: Explain the experimental data analysis.	Understand
CO 3: Explain the concepts of Temperature measurement	Understand
CO 4: Explain the Thermal and transport property measurements	Understand
CO 5: Explain the data acquisition and processing	Understand

Reference Book(s):

R1. Holman J P, "Experimental Methods for Engineers",MCGraw-Hill Education private limited, New Delhi, 2017.

R2. Principles of Experimental Research Course Packet, F&S printing Department, 2011.

R3. Bevington R P, Robinson D K, "Data Reduction and Error Analysis for the Physical Sciences", McGraw Hill, 2014.

R4. Wheeler J A, Ganji A R, " Introduction to Engineering Experimentation", Prentice Hall, 2015.

Web References:

1. http://www.stat.cmu.edu/~hseltman/309/Book/Book.pdf
2. http://home.iitk.ac.in/~shalab/anova/chapter4-anova-experimental-design-analysis.pdf

Course Code:19CCEN1210	Course Title: BIOLOGICAL NANO STRUCTURE		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain knowledge on the nanostructures and nanoscale phenomenon in cells
2. Summarize the different three dimensional DNA nanostructures and their uses.
3. Explain the concepts involved in protein corona with reference to protein nanoparticles and enzyme nanotechnology.
4. Explain with the glyco-metal, glyco-carbon nanoparticles and their fate
5. Explain the synthesis and applciations of lipid based nanostructures

UNIT I - CELLULAR NANOSTRUCTURES **9 Hours**

Cellular elements in developing functional nanostructures and nanomaterials - nanopatterning. Cytoskeletal nanomechanics. Bacterial and viral nanostructured materials. Plant derived nanostructures-types, evolution and applications.

UNIT II - DNA NANOTECHNOLOGY **9 Hours**

Genome structure and organization in prokaryotes and eukaryotes. Structure and function of nucleic acids. DNA tile assembly, brick assembly, 3D DNA nanostructures, Organic and inorganic DNA nanostructures.

UNIT III - PROTEIN AND ENZYME NANOPARTICLES **9 Hours**

Proteins- Structure, Classification and functions. Protein nanoparticles- Designing, synthesis strategy. Enzymes and Enzyme nanoparticles- properties, structure, Synzymes, ribozymes. Preparation, immobilization and kinetic properties and applications of enzyme nanoparticles in day-day to life.

UNIT IV - CARBOHYDRATES AND GLYCO NANOPARTICLES **9 Hours**

Classification, Nomenclature, Structure, Function of carbohydrates. Glyco-metal nanoparticles and glycocarbon nanotubes conjugates.

UNIT V - LIPIDS AND LIPID BASED NANOPARTICLES **9 Hours**

Structure, function and significance of lipids and membrane transport. Membranous nanostructures and their role in cellular traffic. Lipid-based nanomaterials.

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the Nano scale phenomenon associated with cellular nanostructures.	Understand
CO2: Summarize the nature of DNA bricks, aptamers and origami.	Understand
CO3: Explain the design and utilize the protein and enzyme based nanostructures.	Apply
CO4: Classify glycol nanostructures based on their binding ligands.	Understand
CO5: Explain membrane transport and membrane based nanostructures and their uses.	Understand

Reference Book(s):

R1. CS. Pundir, Enzyme nanoparticles, Elsevier UK, 2015

R2. AlešIglič, DamjanaDrobne, VeronikaKralj-Iglič, Nanostructures in Biological Systems: Theory and Applications Pan Stanford Publishing US, 2015.

R3. Stroscio MA and Dutta M, Biological nanostructures and applications of nanostructures in biology: Electrical, Mechanical and optical properties. Kluwer academic publishers New York, 2004.

R4. Luigi Sasso,Self-Assembled Peptide Nanostructures: Advances and Applications in Nanobiotechnology. Pan Stanford Publishing US, 2012

R5. Carlos Aelman, Peptide Materials: From Nanostuctures to Applications, Wiley UK, 2013.

R6. Keith J. Stine,Carbohydrate Nanotechnology, Wiley New Jersey, 2015 .

R7. YonggangKi,3D DNA Nanostructure, Humana Press Inc.New York, 2015

Web References:

1. http://home.iitk.ac.in/~anandh/MSE694/Introduction_to_Nanomaterials-3.pdf

2. https://arxiv.org/ftp/arxiv/papers/0801/0801.3280.pdf

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SEMESTER III - ELECTIVES

Course Code:19CCEN1301	Course Title: TRIBOLOGY IN DESIGN		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Identify the tribological problems in real environment.
2. Discuss how to rectify tribological problems.

UNIT I - SURFACES, FRICTION AND WEAR **9 Hours**

Topography of surfaces – Surfaces features – Experimental Determinations of surface structure – Chemical analysis of surface – surface effects in Tribology – Analysis of surface roughness – measurement of surface roughness. Friction – Mechanism of friction, measuring friction, equations and models of friction – Friction properties of metallic and non metallic materials, friction in extreme conditions. Wear – Types, mechanism, mapping, measurements, wear resistance materials – surface treatment, surface modifications and surface coatings. Computer Simulations of friction, lubrication and wear.

UNIT II - LUBRICATION THEORY **9 Hours**

Lubricants – selection criteria – lubrication regimes – Hydrodynamic, elasto and plasto hydrodynamic lubrication, basic equations, Reynold's equation, energy equation, boundary lubrication, boundary lubricating films and its properties. Hydrostatic lubrication – Gas lubrication

UNIT III - DESIGN OF FLUID FILM BEARINGS **9 Hours**

Dynamic analysis of hydrodynamic bearing performance, trust and journal bearings– full, partial, fixed and pivoted – mass flow rate, friction, power loss, heat and temperature difference, dynamic loads, oil film thickness, stiffness of squeeze film and dynamic co-efficient – hydrostatic bearing design.

UNIT IV - INDUSTRIAL COMPONENTS AND SYSTEMS **9 Hours**

Slider bearings – self-acting finite bearings, failure modes, materials rolling element bearings – Types, contact mechanics, bearing internal load distribution, lubrication – Bearing geometry and kinematics, load ratings and life prediction, torque calculation, temperature analysis, endurance testing and failure analysis.

UNIT V - SPACE AND AUTOMOTIVE TRIBOLOGY 9 Hours

Introduction – Mechanism, components, liquid and solid lubricants, accelerated testing and life testing of space mechanism. Principles of Aerospace eccentric bearing test mechanism. Engine Tribology – importance, lubrication regimes, engine bearings, wheel bearings, tire. Mechanics of load transfer – contact area and normal pressure distribution, brakes, effects of service on engine oil properties. Tribology in manufacturing – macro and micro tribology of MEMS materials. Technologies for machinery diagnosis and prognosis.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the surfaces, friction and wear of materials.	Understand
CO2: Describe the lubrication theory of materials.	Understand
CO3: Design of fluid film bearings.	Apply
CO4: Describe the industrial components and systems for bearings.	Understand
CO5: Describe the space and automotive tribology.	Understand

Reference Book(s):

R1. Bharat Bhushan. "Introduction to Tribology" 2nd Edition", 2013

R2. M.J. Neale, "Tribology Handbook, 2nd Edition, 2016.

Web References:

1. https://www.springer.com/us/book/9781468489767
2. https://www.elsevier.com/books/tribology-in-machine-design/stolarski/978-0-08-051967-8.

Course Code:19CCEN1302	Course Title: MECHANICS OF COMPOSITE MATERIALS		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Explain the characteristics and properties of composites, reinforcements and matrices
2. Explain the various fabrication methods of composite materials.
3. Understand the performance of composite materials.
4. Understand elastic moduli of composite materials
5. Explain composite structure and lamination theory of composite materials.

UNIT I - INTRODUCTION TO COMPOSITE MATERIALS **9 Hours**

Definition – Need- Characteristics and properties, Applications of composites – Reinforcements/Fibers- role and selection of reinforcements- function of reinforcement - Characteristics and properties of fibers -Types of fibers -glass fibers, carbon fibers, aramid fibers, metal fibers, alumina fibers, boron fibers, silicon carbide fibers - Matrices – function of matrices - Characteristics and properties of matrices –Types of matrices – polymer matrix , ceramic matrix, carbon matrix and metal matrix.

UNIT II - FABRICATION METHODS OF COMPOSITE MATERIALS **9 Hours**

Fabrication methods- Hand layup-Autoclave- Filament winding- Compression molding-pultrusion – pre-peg layer. Processing of MMC- diffusion bonding – stir casting – squeeze casting.

UNIT III - PERFORMANCE OF COMPOSITES **9 Hours**

Static Mechanical Properties – tensile, compressive, impact and shear testing of composites - Fatigue, S-N curve – Environmental effects – Long term properties, Fracture Behavior and Damage Tolerance of composites.

UNIT IV - MECHANICS OF COMPOSITES **9 Hours**

Rule of mixture -volume and mass fractions – density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi-Empirical model-Longitudinal Young's modulus-transverse Young's modulus–major Poisson's ratio-In-plane shear modulus, ultimate strengths of a unidirectional lamina.

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UNIT V - COMPOSITE STRUCTURES AND LAMINATION THEOTY **9 Hours**

Introduction to structures- selection of structure materials – composite joint design - bonded joints – bolted joints – composite joint design member examples- tension, compression and torsional members. Characteristics of Fiber-reinforced lamina–laminates–lamination theory, Inter-laminar stresses - Application of FEM for design and analysis of laminated composites.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the characteristics and properties of composites, reinforcements and matrices.	Understand
CO2: Explain the various fabrication methods of composite materials.	Understand
CO3: Explain the performance of composite materials.	Understand
CO4: Explain the elastic moduli of composite materials and lamination theory.	Understand
CO5: Explain composite structure and lamination theory of composite materials.	Understand

Reference Book(s):

R1. Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", CRC Press, 3rd Edition, 2007.

R2. Autar K. Kaw, "Mechanics of Composite Materials", 2nd Edition, CRC Press,2006.

R3. Gibson, Ronald F. Principles of composite material mechanics. CRC press, 2016.

R4. Chawla K.K., "Composite materials", 3rd Edition, Springer – Verlag,2013.

R5. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", 4th Edition, John Wiley and Sons, New York,2017.

Web References:

1. https://www.me.iitb.ac.in/~ramesh/courses/ME338/comp.pdf
2. http://home.iitk.ac.in/~mohite/Composite_introduction.pdf
3. https://nptel.ac.in/courses/112104168/
4. http://web.eng.fiu.edu/wangc/EGN3365-16.pdf

Passed in Board of Studies meeting held on 02.04.19

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BOS Chairman

Course Code:19CCEN1303	Course Title: OPTIMIZATION TECHNIQUES IN DESIGN		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives

The course is intended to:

1. Understand the Principles of optimization and its needs
2. Explain various conventional optimization techniques
3. Solve multivariable problems
4. Solve problems using Unconventional optimization techniques
5. Apply optimization to design of machine elements

UNIT I - INTRODUCTION **9 Hours**

General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objectives function, design constraints – Classification of optimization problem.

UNIT II - UNCONSTRAINED OPTIMIZATION **9 Hours**

Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, pattern and gradient search methods – Interpolation methods.

UNIT III - CONSTRAINED OPTIMIZATION **9 Hours**

Optimization with equality and inequality constraints - Indirect methods using penalty functions, Lagrange multipliers; Geometric programming- Constrained, mixed inequality and unconstrained minimization; Genetic algorithms.

UNIT IV - STATIC APPLICATIONS **9 Hours**

Structural applications – Design of simple truss members. Design applications – Design of simple axial, transverse loaded members for minimum cost, maximum weight – Design of shafts and torsionally loaded members – Design of springs.

UNIT V - DYNAMIC APPLICATIONS **9 Hours**

Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the principles of optimization for mechanical elements.	Understand
CO2: Apply various unconstrained optimization techniques.	Apply
CO3: Apply various constrained optimization techniques.	Apply
CO4: Apply optimization techniques to solve static design problems.	Apply
CO5: Apply optimization techniques to solve dynamic design problems.	Apply

Reference Book(s):

R1. SingiresuS.Rao., "Engineering Optimization Theory and Practice", Wiley; 4th edition 20, 2014 .

R2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 2012.

R3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 2005.

R4. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison-Wesley, New York, 2009.

R5. Saravanan.R, "Manufacturing optimization through intelligent techniques", Taylor and Francis Publications, CRC Press, 2014.

Passed in Board of Studies meeting held on 02.04.19

BOS Convener

Approved in Academic Council meeting held on 27.07.19

BOS Chairman

Course Code:19CCEN1304	Course Title: MATERIAL TESTING AND CHARACTERIZATION TECHNIQUE		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. To identify the microstructure evaluation, crystal structure analysis of critical materials.
2. To know the working principles of microscopies and to acquire the knowledge of static and dynamic mechanical testing methods.

UNIT I - MICRO AND CRYSTAL STRUCTURE ANALYSIS **9 Hours**

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

UNIT II - ELECTRON MICROSCOPY **9 Hours**

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications Atomic Force Microscopy- Construction & working of AFM - Applications .

UNIT III - CHEMICAL AND THERMAL ANALYSIS **9 Hours**

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravitymetric Analysis (TGA)

UNIT IV - MECHANICAL TESTING – STATIC TESTS **9 Hours**

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

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UNIT V - MECHANICAL TESTING – DYNAMIC TESTS **9 Hours**

Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain about crystal structure analysis for materials.	Understand
CO2: Choose an appropriate microscopy for material characterizing.	Understand
CO3: Choose an appropriate material characterizing method to get required results and to study its interface	Understand
CO4: Explain the mechanical properties of bulk materials	Understand
CO5: Explain the dynamic properties of bulk materials	Understand

Reference Book(s):

R1. Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.

R2. Suryanarayana A. V. K., Testing of metallic materials, (2nd Edition), BS publications, 2007.

Web References:

1. https://link.springer.com/book/10.1007/978-3-540-38967-5
2. https://www.sciencedirect.com/science/article/pii/S096112900080006X

Passed in Board of Studies meeting held on 02.04.19 Approved in Academic Council meeting held on 27.07.19

BOS Convener BOS Chairman

Course Code: 19CCON1301	Course Title: AUTOMATION SYSTEMS		
Course Category: Open Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Describe the need of automation
2. Describe various pneumatic control elements
3. Describe the parts of PLC
4. Describe the PLC programming
5. Analyze different type of automation systems

UNIT I - FUNDAMENTAL CONCEPTS OF AUTOMATION — 9 Hours

History and developments in industrial automation, vertical integration of industrial automation, fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, and levels of automation control elements in industrial automation

UNIT II - PNEUMATIC SYSTEMS — 10 Hours

Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions modules and integration - sequential circuits - cascade methods - step counter method. Electrical elements to control pneumatic equipment's - selection of components - design calculations -application - fault finding – low cost automation - robotic circuits.

UNIT III - BASICS OFPROGRAMMABLE LOGIC CONTROLLERS — 9 Hours

Basics of PLC, advantages, capabilities of PLC, architecture of PLC, scan cycle, types of plc, types of i/o modules, configuring a plc, plc wiring.

UNIT IV - PLC PROGRAMMING — 10 Hours

Types of programming - simple process control programs using relay ladder logic - PLC arithmetic functions - timers and counters –data transfer-comparison and manipulation instructions

UNIT V - CASE STUDIES — 7 Hours

Case studies of machine automation, process automation, and selection parameters for PLC and real time interfacing

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Describe the need of automation for industrial applications	Understand
CO2: Describe various pneumatic control elements for low cost automation	Understand
CO3: Describe the functional parts of PLC used for automation	Understand
CO4: Develop logic programmes for real time applications using PLC	Create
CO5: Analyze different type of systems such as machine and process automation	Analyze

Reference Book(s):

R1. Esposito Anthony, "Fluid Power With Applications", Pearson education inc., New York, 2013

R2. Petruzella, Frank D,"Programmable logic controllers", The McGraw-Hill Companies, Inc 2018

R3. Devadas Shetty and Richard A.Kolk, "Mechatronics Systems Design", Cengage Learning Inc 2010

R4. Majumdar.S.R ," Pneumatic Systems: Principles and Maintenance", Mcgraw Hill 2006.

Web References:

1. http://www.cedrat.com/en/publications/categories/devicesystems/systems/mechatronics.html
2. https://en.wikipedia.org/wiki/mechatronics

Passed in Board of Studies meeting

BOS Convener

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BOS Chairman

Course Code: 19CCON1302	Course Title: ENTERPRISE RESOURCE PLANNING		
Course Category: Open Elective		Course Level: Mastery	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

The course is intended to:

1. Gain knowledge on planning an enterprise
2. Apply technology related developments
3. Apply ERP implementation strategies and relate organizational issues
4. Apply ERP on the net.

UNIT I - ENTERPRISE RESOURCE PLANNING **10 Hours**

Principle – ERP framework – Business Blue Print – Business Engineering vs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models.

UNIT II - TECHNOLOGY AND ARCHITECTURE **10 Hours**

Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

UNIT III - ERP SYSTEM PACKAGES **10 Hours**

SAP - People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.

UNIT IV - ORACLE **7 Hours**

Overview – Architecture – AIM: – applications – Oracle SCM. SAP: Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET.

UNIT V - ERP PROCUREMENT ISSUES **8 Hours**

Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the knowledge on planning an enterprise	Apply
CO2: Apply technology related developments	Apply
CO3: Apply ERP implementation strategies and relate organizational issues	Apply
CO4: Apply ERP on the net	Apply

Reference Book(s):

R1. Sadagopan. S, ERP-A Managerial Perspective, Tata McGraw Hill, 2017.

R2. Vinod Kumar Crag and N.K.Venkitakrishnan, Enterprise Resource Planning – Concepts and Practice, Prentice Hall of India, 2015.

R3. ERPWARE, ERP Implementation Framework, Garg&Venkitakrishnan, Prentice Hall, 2011.

R4. Thomas E Vollmann and BeryWhybark, Manufacturing and Control Systems, Galgothia Publications, 2013.

R5. Jose Antonio Fernandez, The SAP R/3 Handbook, Tata McGraw Hill, 2013.

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