Medi-Caps University, Indore

Faculty of Engineering
Syllabus for Doctor of Philosophy
(Mechanical Engineering)

Department of Mechanical Engineering

CURRICULUM AND SYLLABUS

(2023-2027)

Doctor of Philosophy (Mechanical Engineering)

Medi-Caps University, Indore

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Vision Statement of University

Be an internationally acclaimed University recognized for its excellent teaching, research, innovation, outreach and creating top class technocrats and professionals who can serve the mankind as multi skilled global citizen.

Mission Statement of University

- Establish state-of-the-art facilities for world class education and research.
- Conduct scholarly research and creative endeavours that impact quality of life.
- Attract quality staff and students to cater for diverse needs and preferences and widen participation.
- Build a foundation for students to be successful at all levels through high-quality, innovative programs.
- Collaborate with institute, industry, and society to address current issues through research and align curriculum.
- Involve in societal outreach programs to identify concerns and provide sustainable ethical solutions.
- Encourage life-long learning and team-based problem solving through an enabling environment.

Vision of the Department:

To develop engineers of par excellence to meet the ever-changing requirements of industries, motivated towards innovation, entrepreneurship and research in mechanical and allied engineering along with strong human values and ethics for the benefit of society and nation at large.

Mission of the Department:

1. To offer a platform to the students where they will be able to groom themselves technically as industry ready professionals.
2. To develop research environment where students will be motivated to enhance their knowledge to undertake research in mechanical and allied engineering.
3. To collaborate with industries, education institutes of excellence and alumnus to share

and exchange latest technology and innovation.

4. To design curriculum to motivate and sensitize students towards environmental issues and respect for human values and ethics.
5. To develop conducive academic environment in the department to attract qualified faculties members from all around the country.

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Program Education Objectives (PEOs)

PEO -1 To provide advanced knowledge for finding solutions of complex practical problems.

PEO-2 To develop research acumen for designing a system with better efficiency and performance.

PEO-3 To prepare students as experts with better communication skills, professional ethics and team spirit for working in multidisciplinary teams.

Department of Mechanical Engineering

PROGRAMME OUTCOMES (POs)

After the completion of the program, students shall be able to: -

PO_{01} Have a strong foundation in the fundamentals of basic as well as current enginee theories and their applications in real life.

PO_{02} Equip with the skills to analyze problems, formulate a hypothesis and experiment, eval and validate results, and draw reasonable conclusions.

PO_{03} Articulate ideas and strategies for addressing a research problem.

PO_{04} Have proficiency in analytical reasoning, critical thinking and problem solving, as app to scientific problems.

PO_{05} Effectively communicate research, through journal publications and confere presentations, to the scientific community.

PO_{06} Have skills to explore new areas of research in fields of engineering and technology.

PO_{07} Have an ability to adopt ethical practices in developing scientific solutions for the l issues being faced by our society.

PO_{08} Develop an ability to identify unsolved yet relevant problems in a specific field.

PO_{09} Participate as a member of the mechanical engineering and interdisciplinary probl solving team.

PO_{10} Have an ability to develop innovative and cost-effective techniques and products.

PO_{11} Commit to the professionals, legal and social responsibilities of a researcher.

PO_{12} Develop an ability to engage in life-long learning by adapting knowledge of contempo issues.

Department of Mechanical Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1: Acquire, Develop and Demonstrate knowledge in the area of Automobile Design Automotive Systems, Machine Component Design, Finite Element Method, Thermal Engineering, Manufacturing and Development of Mechanical system.

PSO 2: Apply concepts of learning, Managerial skills, Computational skills and Research methodologies, techniques & tools to solve Industrial problems and become a successful Entrepreneur.

PSO 3: Develop the ability to automate a mechanical system or a process to meet desired needs within realistic constraints such as health, safety and manufacturability.

PSO 4: Apply research-based knowledge and research methods including design of experiments, analysis and interpretation of data.

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Course Work:

Sr. No.	Course Code	Course Name	L	T	P	Credit
1	EN6ME04 / EN6ME05 / EN6ME06 / EN6ME07	Program Specific Course:1	4	0	0	4
2	EN16RD01	Research Methodology	4	0	0	4
3	MU6RD01	Research and Publication Ethics	2	0	0	2
		Total	**10**	**0**	**0**	**10**
		Total Contact Hours	10			

Program Specific Course: 1

Course Code	Course Name	Specialization
EN6ME04	Design Engineering	DesignEngineering
EN6ME05	Industrial Engineering & Management	IE & MEngineering
EN6ME06	Thermal and Fluids Engineering	Thermal & FluidEngineering
EN6ME07	Advanced Manufacturing Technology	AMTEngineering

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Course Code	Course Name	Hours per Week			Total	Total
		L	**T**	**P**	**Hrs.**	Credits
EN6ME04	Design Engineering **(Design)**	4	0	0	4	4

Chapter 1
Crack tip plastic zone, Implications of crack tip plasticity, Stable crack extension, R-Curve Concept, Elastic-plastic fracture, J-Integral concept. Crack arrest methodology. Dynamic-fracture. Fracture testing methodologies. Application of fracture mechanics to Fatigue crack growth. Crack closure mechanisms. Need for fracture based design; design methodologies – safe-life, fail-safe, damage tolerance design; Stress Concentration Factors; Stress Intensity Factors; Griffith's energy balance criteria; Dugdale's correction to Griffith's criteria; Compliance-Energy Release correlation.

Chapter 2
Noise control, non-linear and multi-body dynamics, fluid-structure-acoustic interactions, Vibrations, Acoustics Vibrations, condition monitoring, acoustics. Nonlinear vibrations and random vibrations, Two degree of freedom systems, Multi degree of freedom.

Chapter 3
Definition of Stress, Coordinate Changes and the Stress Tensor, Principal Stresses, Octahedral Stresses Definition of Strain, Strain Tensor, Mohr's Circle for Strain, Plastic Strain engineering and true strain, Poisson's Ratio and incompressibility, Dislocation Theory for Metals, Two-Dimensional Problems - plane stress and plane strain problems, Techniques for Solving the Equations of Elasticity, Linear Thermo-elasticity.

Chapter 4
Fatigue and fracture of advanced engineering materials, new surface modification process, tribobehaviour of polymer nano-composites, polymer composite gears development and performance, new sintered steels for tribo applications, fretting wear and fretting fatigue, friction and wear characteristics. Surface engineering-wear and wear control, thermal sprayed coatings, multi axial fatigue- mixed mode fracture, ceramic coatings, tribology, failure analysis. Creep Mechanisms.

Chapter 5
Computer Aided Simulation and Design Optimization, Linear and non-linear vibrations, Chaos, Vehicle Dynamics, Rotor Dynamics, Acoustics and Noise, Active Vibration and Noise Control, Smart Structure, Robotics, Kinematics and control of Rigid and Flexible Manipulators, Microprocessor based control and automation, Mechatronics, Mobile Robots, Textile Machinery MEMS.

References:

1. Lecture Notes on Fracture Mechanics, NAL – Dr. K N Raju, Vol 1, 1979 (also available as STC course lecture by T S Ramamurthi, IISc, Bangalore).
2. Fracture Mechanics: Fundamentals and Application – T. L. Anderson, CRC Press, 3/e, 2004. Chapters 2 and 3
3. ASTM Annual book of standards 3.01 for experimental methods of fracture parameter determination ASTM E-399, E-647, E-1820.
4. K. Ramesh, NPTEL lecture notes on Fracture Mechanics.
5. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International P) Limited, New Delhi, 2000.
6. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
7. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995.
8. Vibration condition Monitoring, J.S. Rao.
9. Advanced Strength of Materials, J. P. Den Hartog, Dover Publications Inc.

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Course Code	Course Name	Hours per Week			Total	Total
		L	**T**	**P**	**Hrs.**	Credits
EN6ME05	Industrial Engineering & Management **(IE & M)**	4	0	0	4	4

Chapter 1

Industrial Engineering: Meaning, Definition, Objective, Need, Scope, Evolution and developments.

Productivity: Definition of productivity, Difference between production and productivity, Factors to improve productivity individual enterprises, task of management Productivity of materials, land, building, machine and power. Measurement of productivity, factors affecting the productivity, productivity improvement programs, wages and incentives (numerical problems).

Chapter 2

Work Study: Definition, advantages and procedure of work-study.

Method Study: - Definition, objectives and procedure of method study. Symbols, flow process chart (man-machine-material), flow diagram, machine chart, two hand chart Critical examination. Developing a new method Principles of motion economy.Therblig symbols, SIMO chart, simple problems.

Time study: - Definition, principle and method of time study Stop watch study - number of reading, calculation of basic time, rating techniques, normal time, allowances, standard time Simple numerical problems. Work Sampling - Definition, method, advantages and disadvantage of work sampling Applications.

Chapter 3

Facility Planning:- Site selection theories, Material handling systems, Warehouse layout models, plant location problems, Conveyor design., Deterministic models – single and multi facility location models, Job Allocation problems - quadratic assignment problems, Physical facilities – Algorithm, Automated Guided Vehicles (AGV's),

Chapter 4

Planning and managing operations: Demand Forecasting, Purchasing, vendor selection and material management, Inventory Management & Just-in-Time Systems, MRP I, MRP II and ERP Aggregate Operations Planning, Product structure tree, Routing, Loading, Scheduling – forward and backward, Dispatching – priority rules, Sequencing, Johnson's algorithm for n jobs and two machines, Gantt's chart, Bar chart, Flow process chart.

Advance operation management: Service Operations Management, Lean systems, Constraint management – TOC, Computer integrated manufacturing, Analytical tools for *decision support system* (DSS) for operations management, Kanban and CONWIP, shop floor controls, Kaizen.

Chapter 5

Introduction to supply chain: Definition, complexity, key issues, centralized vs. decentralized systems. Value of information and supply chain integration, Bullwhip effect, Push-based, pull based systems. Outsourcing, Make or buy decisions.
Recent Trends in Supply Chain Management: Introduction, New Developments in Supply Chain Management, Outsourcing Supply Chain Operations, Co-Maker ship, The Role of E-Commerce in Supply Chain Management, Green Supply Chain Management, Distribution Resource Planning, World Class Supply Chain Management.

Text Books:

1. R B Khanna, Production and Operations Management, PHI.
2. Chase, Jacobs and Aquilano, Operations Management for Competitive advantages, TMH.
3. Sunil Chopara and Peter Meindl, Supply Chain Management: Strategy, Planning, and Operation, Pearson.

References Books:

1. Everett Adam, Ronald J Ebert, Production and Operations Management, PHI.
2. Simchi-Levi, Keminsky, Designing and Managing the supply chain, TMH.
3. Introduction to work study, ILO.

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Course Code	Course Name	Hours per Week			Total	Total
		L	**T**	**P**	**Hrs.**	Credits
EN6ME06	Thermal and Fluids Engineering **(Thermal & Fluid)**	4	0	0	4	4

Chapter 1

Design of Thermal System: Principle of thermal design, system simulation and optimization, modeling of typical thermal equipment, dynamic response of thermal system, methods of optimization, search methods, dynamic and geometric programming.

Chapter 2

Computational Fluid Mechanics and Heat Transfer: Differential equations of motion in fluid flow - Navier stokes equation, different technique for solving boundary layer problems, elementary idea of CFD. Two –dimensional steady and unsteady state heat conduction processes, extended surfaces: fins, finite difference method for conduction and convection .

Chapter 3

Waste Heat Recovery: properties of exhaust gas, gas-air heat recovery, gas water heat recovery, Garrett pyrolysis process, Kinney thermal recovery process, heat recovery by steam generation, waste heat recovery in steel making, organic rankine cycle combined power plant.

Chapter 4

Refrigeration and A/C systems: Air cycle of refrigeration, principle of psychrometry, different psychrometric processes mathematical analysis of a simple and actual vapour compression refrigeration cycle, practical absorption refrigeration cycle, estimation of cooling load calculation.

Chapter 5

Solar Energy: Solar radiation, availability different , measurement and estimation, different types of solar collectors, solar thermal conversion devices and storage, application. Solar photovoltaic conversion. Power from renewable sources (wind, tidal, ocean thermal, geothermal, biomass and small hydro etc)

References:

1. Design of thermal systems, third edition, W. F. Stoecker, Mcgraw-hill book company
2. Introduction to Fluid Mechanics, sixth edition, Robert W Fox, Alan T Mc Donald, Philip J. Pritchard, John Wiley & Sons.
3. Fuel Economy in furnaces and Waste heat recovery-PCRA & Bureau of Energy Efficiency.
4. Heat Recovery Systems by D.A.Reay, E &F.N.Span, London, 1979.

5. Air Conditioning and Refrigeration, Rex Miller & Mark R. Miller, McGraw-Hill
6. Garg H.P. and Prakash S (1997), Solar Energy: Fundamental and Application, Tata McGraw Hill, New Delhi.
7. Kreith F. and J. F. Kreider, (1978), Principles of Solar Engineering, McGraw Hill.

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		L	**T**	**P**	**Hrs.**	Credits
EN6ME07	Advanced Manufacturing Technology **(AMT)**	4	0	0	4	4

Chapter 1

Introduction: Need and comparison between traditional, nontraditional machining process, Classification of advanced machining process, Hybrid Process, High speed machining, Cryogenic machining,Concept of Machinability and its Improvement.

Chapter 2

Non-conventional processes: Mechanism of material removal for Ultrasonic machining, water jet machining, electric discharge machining, electrochemical machining, plasma arc machining effect of process parameters and variables, applications and limitations.

Chapter 3

Micromachining Processes: Introduction, Diamond turn machining, Application and technique of Micro milling, abrasive jet micromachining, magnetorheological Nano finishing process, Electron beam Micromachining, Magnetic Float Polishing for ceramic balls.

Chapter 4

Computer integrated manufacturing Systems, Automation of manufacturing process, Computer Numeric Control, Adaptive control, Group technology, Cellular manufacturing, Flexible Manufacturing system, Just-in Time Production, Lean manufacturing, and Artificial Intelligence.

Chapter 5

Rapid Prototyping: Stereo-lithography, Fused-deposition modeling, Selective laser sintering, Laminated-object manufacturing, 3D printing, subtractive v/s additive manufacturing process LIGA Process,Rapid Tooling, Jigs and Fixtures for Machine shops.

Text Books:

1. D.G. Boothroy and W.A Knight. "Fundamentals of Machining and Machine tools", Marcel Dekker, New York.
2. M.P.Groover“Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, John Wiley and Sons.
3. V.K. Jain “Advanced Machining Process”, Allied Publishing Pvt. Ltd.

Reference Books:

1. S Kalpakjian and S. Schmid, “Manufacturing Processes for Engineering Materials”, Pearson.
2. V.K.Jain, “Introduction to Micromachining”, Narosa Publishing House.
3. Amitabha Ghosh, Ashok Kumar Mallik, “Manufacturing science”, East-West Press Pvt. Ltd.
4. Yi Qin “Micro-Manufacturing Engineering and Technology”, Elsevier Publication.
5. P.C.Pandey “Modern Machining Processes”, Tata McGraw Hill, New Delhi.

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Subject Code	Subject Name	Hours per Week			Total Credits
		L	T	P	
EN16RD01	Research Methodology **(Common to All)**	4	0	0	4

Unit-I

Introduction to Research Techniques : Meaning of research, objectives of research, motivation in research, types of research-Introduction to experimental test bed, algorithmic research, simulation research, mathematical modelling approach, characteristics and prerequisites of research, significance of research, research process, Sources of research problem, criteria of identifying the problem, necessity of defining the problem, errors in selecting research problem, technique involved in defining the problem, Report and paper writing.

Unit-II

Statistical analysis: Statistical analysis: Measures of central tendency and dispersion,-mean, median, mode, range, mean and standard deviations, computing correlation in variables, linear and non-linear regression.

Unit-III

Probability and Probability distributions: Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes'Theorem and independence. Probability distributions: binomial, poison, geometric, negative binomial uniform exponential, normal and log normal distribution.
Random Variables: Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median and quintiles, Markov inequality, correlation and regression, independence of random variables.

Unit-IV

Sampling &Distributions: Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems. Hypothesis Testing: Basic ideas of testing hypothesis, null and alternative hypotheses, the critical and acceptance regions, two types of error, tests for one sample and two sample problems for normal populations, tests for proportions, Chi-square goodness of fit test and its applications. Software and Tools to be learnt: Statistical packages like SPSS and R.

Unit-V

Simulation and Soft Computing Techniques: Introduction to soft computing, Artificial neural network, Genetic algorithm, Fuzzy logic and their applications, Tools of soft computing, Need for simulation, types of simulation, simulation language, fitting the problem to simulation study, simulation models, verification of simulation models, calibration and validation of models, Output analysis. Introduction to MATLAB, NS2, ANSYS, Cadence etc(Department Specific).

Text Books:

1. R. Panneerselvam, “Research Methodologies” PHI.
2. C.R. Kothari: Research methodology, Methods and Techniques, 2000.
3. S.M. Ross, a First Course in Probability, 8 th Edition, Prentice Hall, 2009.

Reference Books:

1. Best John V. and James V Kahn: Research in Education, Wiley eastern, 2005.
2. S.P. Sukhia, P.V. Mehrotra, and R.N. Mehrotra: Elements of Educational Research, PHI publication, 2003.
3. K. Setia: Methodology of Research Education, IEEE publication, 2004.
4. Jerry Banks, John S. Carson, Barry.L. Nelson David. M. Nicol, “Discrete-EventSystem Simulation”, Prentice-Hall India.
5. V.K. Rohatgi, A.K. Md.E.Saleh, an Introduction to Probability and Statistics, JohmWilley, 2011.

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MU6RD01	**Research and Publication Ethics**	2	0	0	2

Unit-I

Philosophy, Ethics and Paradigm of Research: Introduction to Philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral Philosophy, nature of moral judgments and reactions. Philosophy of scientific research, research paradigm, approaches and components of research paradigm, artifacts, values and beliefs.

Unit-II

Scientific Conduct: Ethics with respect to science and research, Ethics in Measurement Practices , Ethics aspects of Funding policies, Intellectual property rights, Intellectual honesty and research integrity,Scientific misconducts: Whistle blowing, Falsification, Fabrication and Plagiarism(FFP), Image manipulation, violation of copy right act. Redundant publication: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data .

Unite-III

Publication Ethics: Definition, introduction and importance, responsibilities of authors, Best practices/standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest, privacy and confidentiality. Publication misconducts: definition, concepts, problems that lead to unethical behavior and vice versa, types. Editorial and review ethics , Violation of publication ethics, authorship and contributor-ship, Withdrawal of articles,Data protection legislation. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.

Unit-IV

Open Access Publishing: Open access publications and initiatives. SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies. Software tools to identify predatory publications developed by SPPU. Journal finder/Journal suggestion tool viz. JANE, Elsevier finder, Springer journal suggester, etc.

Unit-V

Database and Research Metrics:

Database: Indexing database. Citation database: Web of Science, Scopus, etc.

Research Metrics: Impact factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g-index, i10 index, altmetrics.

Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.

Group Discussions and Case Study: Subject specific ethical issues, FFP, Authorship. Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad.

Text Book :

1. Chaddah Praveen (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN: 978-9387480865.
2. Day RA (1979) How to write and publish a scientific paper. ISI press, Philadelphia.
3. Committee on Publication Ethics (COPE): Guidelines on good publication practice (https://publicationethicsorg/resources/guidelines)
4. Moore A (2013) What's in a peer review report?. Bio Essays.

Reference Book:

1. The Ethics of Teaching and Scientific Research By Miro Todorovich; Paul Kurtz; Sidney Hook.
2. Research Ethics: A Psychological Approach By Barbara H. Stanley; Joan E. Sieber; Gary B. Melton.
3. Research Methods in Applied Settings: An Integrated Approach to Design and Analysis By Jeffrey A. Gliner; George A. Morgan Lawrence Erlbaum Associates, 2000.
4. Ethics and Values in Industrial-Organizational Psychology By Joel Lefkowitz Lawrence Erlbaum Associates, 2003.
5. Bird, A. (2006). *Philosophy of Science*. Routledge.
6. Mac Intyre, Alasdair (1967) *A short History of Ethics*. London.
7. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). *On being a Scientist: A Guide to Responsible Conduct in Research; Third Edition*, National Academies Press.
8. Resnik, D. B. (2011), What is ethics in research & why is it important. *National Institute of Environmental Health Sciences*, 1-10. Retrieved from http://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm.
9. Beall, J. (2012), Predatory publishers are corrupting open access. Nature, 489 (7415), 179-179. http://doi.org/10.1038/489179a.
10. Indian National Science Academy (INSA), Ethics in Science Education, Research Governance (2019), ISBN: 978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf.