UNIVERSITY INSTITUTE OF ENGINEERING & TECHNOLOGY MAHARSHI DAYANAND UNIVERSITY, ROHTAK

SCHEME OF STUDIES & EXAMINATIONS

Doctor of Philosophy (Ph.D.) –MECHANICAL ENGINEERING Course Work

Scheme of Examination w.e.f. 2020-21

(i)The duration of the Ph.D. course work will be of one semester.

ii) The Department concerned shall design the Ph.D. course as per latest guidelines ofUGC.

iii) The scheme for Ph.D. course work is asunder:

a) Commoncourses:

20MEPH11C1: Research Methodology (Quantitative Techniques and Computer Applications in Research)

20MPCC1: Research and Publications Ethics

b) Departmentalcourse:

20MEPH11C3: Review of Literature and Seminar (in Relevant Research Area)

c) Elective Subject (Departmental ElectiveSubjects)

iv) The qualifying marks in each paper of the course work shall be50%.

v) It is only on satisfactory completion of Ph.D Programme, which shall be an essential part and parcel of the Ph.D. programme that a candidate shall be eligible to apply for registration in Ph.D. Programme.

S. No.	Course Code	Course Title	Credits	Examination Marks		Total Marks	Duration of Exam
				Theory	Internal**		
1.	20MEPH11C1 (Common Course)	Research Methodology (Quantitative Techniques and Computer Applications in Research)	4	80	20	100	3
2.	20MPCC1 (Common Course)	Research and Publication ethics	2	40	10	50	3
3.	20MEPH11C3	Review of Literature and Seminar (in Relevant Research Area)	4	80	20	100	3
4.		Elective Subject (Departmental Elective Subject) any one from the list attached	4	80	20	100	3
	Total		**14**	**280**	**70**	**350**	

******Eachtheory paper/courseshallhaveaninternalassessmentof20marks.Itshallcomprise oftwowrittenassignmentsand two presentationsof05 markseach. Theconcerned teacher/HeadoftheDepartmentshall maintain therecordonthebasisofwhichinternal assessmenthasbeen awarded forat leastthree monthsafterthedeclaration of result.

Name of the Program	Ph.D. Course work in Mechanical Engineering	**Program Code**	MEPH
Name of the Course	Research Methodology (Quantitative Techniques and Computer Applications in Research)	**Course Code**	20MEPH11C1
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 16 = 80 marks)

Course Objectives:

1. To understand the fundamentals concepts of research process, various models of research and report writingconcepts.
2. To learn various statistical analysis techniques for data analysis and hypothesistesting.
3. To understand the concepts of measurement and scaling & their various techniques and sample sizedetermination.
4. To learn various types of data collection techniques, types of data, analysis and interpretation ofdata.
5. To understand the role of computer in mathematical and statistical analysis in researchand to get the idea about applications of relevant research methodologies with special reference to research in computer science.

Course Outcomes:

1. Learn the concept of research, research process, types of research, research models and basics formats of reportwriting.
2. Learn the use of statistical analytic techniques for data analysis and testing ofhypothesis.
3. Identify the differences between measurement and scaling and how sample is selected and determined using variousapproaches.
4. To understand sources of data collection and how data is collected from differentsources.
5. To understand the concept of interpretation and role of computer in mathematical and Statistical analysis with applications of relevant research methodologies used in computer science&Engineering.

Unit - I

Element of Research

Scientific process meaning and definition, a brief history of scientific process. Introduction to research methodology- Meaning of research, objective of research, types of research, significance of research, problem encountered by researchers in india, Research problem- Definition, necessity and techniques of defining research problem, formulation of research problem, objective of research problem, research design- Meaning, need and features of good research design, types of research designs, basic principles of Experimental design.Sampling design, census and sample surveys, different types of sample designs, characteristics of good sample design, Techniques of selecting a random sample. Data collection-primary and secondary data, methods of selecting primary and secondary data.

Unit - II

Hypothesis &Statistical Analysis

Hypothesis- definition, testing of hypothesis, procedures of hypothesis testing, flow diagram for hypothesis testing, parametric and non-parametric tests for testing of hypothesis, limitations of tests of hypothesis.Hypothesis tests- One sample test-two sample tests/ chi square tests, association of attributes. T-tests, statistical analysis, correlation and regression analysis- analysis of variance, completely randomized design, randomized complete block design, Latin square design-partial and multiplecorrelations

– discriminent analysis - cluster analysis – principle component and factor analysis, repeated

measure analysis.Probability and probability distributions; Binomial, Poisson, distribution, Basic ideas of testing of hypotheses; Tests of significance based on normal distributions.

Unit - III

Paper Writing and Report Generation

Basic concepts of paper writing and report generation, review of literature, concepts of bibliography and references, significance of report writing, steps of report writing, types of research reports, methods of presentation of report**.**

Unit - IV

Computer Applications in Research

Computer Applications: Fundamentals of computers-Definition, types of computers, RAM, ROM, CPU, I/O devices, Number systems-Binary, octal and hexadecimal, base conversion, logic gates- AND, OR, NOT, Operating system-definition, types of operating system, Database system – definition & applications, Networks – definition & applications, Internet & its applications, Web Searching, Email, Uses of software's MS- Office-Power Point, Word, Excel and Access.

Text Books:

1. C. R. Kothari – Research Methodology Methods and Techniques – Wishwa Prakashan Publishers – Second Edition.

Name of the Program	Ph.D. Course work	**Program Code**	MEPH
Name of the Course	Research and Publicationethics	**Course Code**	20MPCC1
Hours/Week	2	**Credits**	2
Max. Marks.	40	**Time**	3 Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 8 = 40 marks)

Course Objectives:

1. To study the philosophy ofethics
2. To study the scientific conduct ofresearch
3. To study the publicationethics
4. To know about various journal citationdatabases
5. To know the importance of qualitypublications

Course Outcomes:

By completion of course the student is able to understand

1. Ethics in conduct of scientificresearch
2. Know the scientificmisconducts
3. How to avoid plagiarism and what are the penalties ofplagiarism
4. Know the quality of researchpublications
5. Write research and reviewarticles.

Unit - I

PHILOSOPHY AND ETHICS

1. Introduction to philosophy: definition, nature and scope, concept,branches
2. Ethics: definition, moral philosophy, nature of moral judgments andreactions

SCIENTIFIC CONDUCT

1. Ethics with respect to science andresearch
2. Intellectual honesty and researchintegrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism(FFP)
4. Redundant publications: duplicate and overlapping publications, salamislicing
5. Selective reporting and misrepresentation ofdata

Unit - II

PUBLICATION ETHICS

1. Publication ethics: definition, introduction andimportance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME,etc.
3. Conflicts ofinterest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa,types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints andappeals
7. Predatory publishers andjournals

Unit - III

DATABASES AND RESEARCH METRICS

(A) Databases

1. Indexingdatabases
2. Citation databases: Web of Science, Scopus,etc.

(B) ResearchMetrics

1. Impact Factor of journal as per Journal Citation Report, SNIP, SIR, IPP, CiteScore
2. Metrics: h-index, g index, i10 index,altmetrics

Unit - IV

Practice

OPEN ACCESS PUBLISHING

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archivingpolicies
3. Software tool to identify predatory publications developed bySPPU
4. Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested,etc.

PUBLICATION MISCONDUCT

(A) GroupDiscussions

1. Subject specific ethical issues, FFP,authorship
2. Conflicts ofinterest
3. Complaints and appeals: examples and fraud from India andabroad

(B) Software tools (2 hrs.) :Use of plagiarism software like Tumitin, Urkund and other open source softwaretools

References:

1. Bird, A. (2006). Philosophy of Science,Routledge
2. P. Chaddah (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarised.
3. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019).
4. Beall, J (2012), Predatory publishers are corrupting open access. Nature, 489(7415), 179.
5. 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 Academicpress.

Name of the Program	Ph.D. Course workin Mechanical Engineering	**Program Code**	MEPH
Name of the Course	Review ofLiterature and Seminar	**Course Code**	20MEPH11C3
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

(in Relevant Research Area)

1. The research student is required to prepare a concept paper/working, paper/review paper by reviewing at least 50 research papers / references books / unpublished doctoral dissertations / other reportsetc.

2. To qualify the paper the research student is required either to present the prepared paper in an International Conference/ Seminar/ Workshop or publish the same in a research journal. Acceptance for publication or presentation will be considered as published/presented.

3. A duly constituted committee of three teachers of the department by the Director/Head shall evaluate the completion of thepaper.

SYLLABUS (Pre PhD-ME)

List of Electives:

20MEPHCE1	COMPUTER AIDEDDESIGN
20MEPHCE2	ADVANCED MECHANICS OFSOLIDS
20MEPHCE3	ADVANCED MANUFACTURINGTECHNIQUES
20MEPHCE4	NON-CONVENTIONALMACHINING
20MEPHCE5	QUALITY & RELIABILITYMANAGEMENT
20MEPHCE6	SOLARENERGY
20MEPHCE7	ADVANCE HEAT AND MASSTRANSFER

Note: Thedepartmentalelectivesubjectswillbeofferedasperavailabilityof expertise and the required infrastructure in thedepartment.

	Ph.D. Course work in Mechanical Engineering	**Program Code**	MEPH
Name of the Course	Computer Aided Design	**Course Code**	20MEPH11CE1
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsoryquestionconsistingofshortanswerfromallunits.Thecandidatehastoattempt onequestioneachfromeachunitalongthecompulsoryquestion(5x16=80marks)

Course Objectives:

1. To study the basics of geometric and solidmodelling
2. To learn about 2D & 3Dtransformations.
3. Tostudytheanalyticalandsyntheticcurves.
4. Tolearnaboutsolidrepresentationscheme.
5. To study about surface modelling and theirtypes

Course Outcomes:

By completion of course the student is able to understand/learn

1. The concept of computergraphics.
2. The different algorithm ofcurves.
3. Identify the differences wireframe, surface and solidmodelling.
4. Transformations in 2D &3D.
5. Surfaces parametric representations & solid representationschemes

Unit – I

Introduction

Introduction,Reviewofvectors&Matrices,Basicsofgeometricandsolidmodeling,explicit, implicit, intrinsic and parametric equations, coordinatesystems.

Transformations

Introduction,transformationofpointsandline,2-Dtranslation,shearing,rotation,reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation,reflectionandtranslation,combinedtransformations,orthographic,axonometric, oblique and perspective projections.

Unit - II

Curves

Geometry and topology, algebraic and geometric forms of straight lines, circles, conics, cubic splines, Ferguson curve, Hermite curve, bezier curves and B-spline curves, NURBS, composite curves, tangents and normal, blending functions, reparametrization.

Unit – III

Solids

Solid models and representation schemes, their properties, boundary representation, constructive solid geometry, sweep representation, cell decomposition, octree encoding, spatial occupancy enumeration.

Unit - IV

Surfaces

Algebraic and geometric forms, tangents and twist vectors, normal, blending functions, reparametrization.Planesurface,sixteenpointform,fourcurveform,ruledsurface,surface ofrevolution,tabulatedcylinder,loftedsurface,bi-cubicsurface,beziersurface,B-spline surfaces, Coons' patch, blending surface, offset surface, rational surface.

Reference Books:

1. CAD/CAM by Groover and Zimmer, PrenticeHall
2. CAD/CAM: Theory and Practice by I. Zeid, McGrawHill
3. Geometric Modeling by M.E.Mortenson

Name of the Program	Ph.D. Course work in Mechanical Engineering	**Program Code**	MEPH
Name of the Course	Advanced Mechanics of Solids	**Course Code**	20MEPH11CE2
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsoryquestionconsistingofshortanswerfromallunits.Thecandidatehastoattempt onequestioneachfromeachunitalongthecompulsoryquestion(5x16=80marks)

Course Objectives:

1. To study about 3-dimensional stresstensor
2. To study about three dimensionalstrains
3. To study the effect of unsymmetricalbending.
4. To learn about bending of plates and contactstresses.
5. To study about buckling of columns and beam on elasticfoundation.

Course Outcomes:

By completion of course the student is able to understand/learn

1. The concept of computergraphics.
2. The different algorithm ofcurves.
3. Identify the differences wireframe, surface and solidmodelling.
4. Transformations in 2D &3D.
5. Surfaces parametric representations & solid representationschemes

Unit – I

Three Dimensional Stress and Strain:

PrincipalstressesandPrincipalstrains,Mohr'scirclerepresentationoftri-axialstressesand strains.

Unsymmetrical Bending:

Shear centres for sections with one axis of symmetry. Shear centre for any unsymmetrical section, stress and deflection of beams subjected to unsymmetrical bending.

Unit - II

Bending of Plates:

Basic definitions, Stress, Curvature and Moment relations, Basic Equation of plate deflection. Different boundary conditions simply supported rectangular plates, axis symmetric loaded circular plates.

Contact Stresses:

Due to Two Spherical Surfaces in Contact, Due to Two Parallel Cylindrical Rollers in Contact, Due to Two Curved Surfaces of Different Radii.

Unit – III

Buckling of Columns:

Beam columns with single concentrated load, number of concentrated loads, continuous lateral load, end couple, couples at both ends of the column, triangular loads and combined loads.

Unit - IV

Beam on Elastic Foundations:

General Theory, Infinite, Semi-infinite, and Finite beams, Classification of Beams. Beam supported by equally spaced elastic elements.

Reference Books:

1. AdvancedStrengthandAppliedElasticity'byUgural&Fenster,PrenticeHall.
2. Advanced Mechanics of Solids' by L., Srinath,TMH
3. Intermediate Mechanics of Materials' by J. R. Barber,McGraw-Hill
4. Introduction to Solid Mechanics' by Shames & Pitarresi,PHI

Name of the Program	Ph.D. Course work in Mechanical Engineering	**Program Code**	MEPH
Name of the Course	Advanced Manufacturing Techniques	**Course Code**	20MEPH11CE3
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 16 = 80 marks)

Course Objectives:

1. To study about advance manufacturingtechniques
2. To study about robust designmethodology
3. Tostudyaboutqualityfunctiondeployment
4. To learn about agile manufacturing and concurrentengineering.
5. To study about advance materials and weldingprocesses.

Course Outcomes:

By completion of course the student is able to understand/learn

1. The advance manufacturingtechniques.
2. The quality functiondeployment.
3. The agile manufacturing and virtual manufacturingsystem.
4. Rapid prototypingtechnology.
5. Advance weldingprocesses

Unit – I

Different Techniques:

Manufacturing Change in manufacturing system, manufacturing strategies, Advanced manufacturing Technologies for Indian Industries, Robust design methodology for Quality Engineering and management

Unit - II

Six Sigma, Taguchi concepts, Quality function deployment, Rapid proto typing: Technology and challenges, Introduction and concepts of JIT, CAPP, MRP, CIMS, FMS, SCM, TPM, Kaizan

Unit – III

Agile manufacturing, Lean Manufacturing, Virtual manufacturing system, kanban, Theory of constrains, synchronous manufacturing, concurrent Engineering

Unit - IV

Advanced Techniques:

Manufacturing and Environmental issues, Advanced materials and their application in manufacturing, Abrasive flow machining , Advanced welding processes (New Solid state Welding, Arc welding and Radiation welding Processes).

Reference Books:

1. Modern Machining Processes, P.C. Pandey and H.S. Shan,TMH
2. Machining Science, Ghosh and Mallik,AEW
3. Non-TraditionalManufacturingProcessesbyG.F.Benedit,MarcelDekker.
4. Advanced Machining Processes by V.K. Jain, AlliedPuiblishers.
5. AdvancedTopicsofStrengthofMaterials'byU.C.Jindal,GalgotiaPublication.

Name of the Program	Ph.D. Course work in Mechanical Engineering	**Program Code**	MEPH
Name of the Course	Non-Conventional Machining	**Course Code**	20MEPH11CE4
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 16 = 80 marks)

Course Objectives:

1. To study the modern machiningprocesses
2. To study about EDM and wireEDM
3. To study laser beammachining.
4. Tolearnabrasivejetmachining,ultrasonicmachiningandabrasivewaterjetmachining
5. To study about ECM andECG

Course Outcomes:

By completion of course the student is able to understand/learn

1. The concepts of modern machiningprocesses.
2. Processes like UCM, AJM, AFF,MAF.
3. Identify the differences EDM and wireEDM.
4. Thermoelectric advanced machiningprocesses
5. Electrochemical and Chemicalprocesses

Unit – I

Introduction:

Need for advanced machining processes; An Overview of Modern machining processes

Unit - II

Mechanical processes:

Abrasive Jet Machining; Ultrasonic Machining; Abrasive Flow Finishing; Magnetic Abrasive Finishing; Abrasive Water Jet Machining

Unit – III

Thermoelectric advanced machining processes:

EDM; Electric Discharge Diamond Grinding; Wire EDM; Laser beam Machining; Plasma Arc Machining; Electron Beam Machining

Unit - IV

Electrochemical and Chemical Processes:

ECM; ECG; Electro stream Drilling; Electrochemical Deburring; Chemical Machining

Reference Books:

1. Advanced Machining Processes by V.K. Jain. Allied Publishers PvtLtd
2. ModernMachiningProcessesbyP.C.PandeyandH.S.Shan.TataMcGraw-Hill

Name of the Program	Ph.D. Course work in Mechanical Engineering	**Program Code**	MEPH
Name of the Course	Quality & Reliability Management	**Course Code**	20MEPH11CE5
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 16 = 80 marks)

Course Objectives:

1. To study quality and factors influencingquality
2. To study different control charts and theirsignificance
3. To study aboutsampling
4. To learn about total qualitymanagement.
5. To study aboutreliability.

Course Outcomes:

By completion of course the student is able to understand/learn

1. The concepts ofquality.
2. The different control charts, their advantages anddisadvantages.
3. Acceptancesampling
4. TQM and ISO9000.
5. Reliability and factor affectingreliability

Unit – I

Introduction:

Conceptofquality,Need,Factorinfluencingquality,Typesofquality,Qualitycontrol,Costof quality control, Quality assurance, Benefits, Modern concept, Inspection and qualitycontrol, Quality characteristics, Qualitycircles.

Statistical Concepts and Control Charts:

Review of fundamental statistical concept, Frequency distribution, Central tendency, measures of dispersion, Probability distributions, statistical quality control, Theory of control charts,Controlchartsforvariablesandattributes(*x*,R,P,npandCchart),theiradvantages and disadvantages, Applications.

Unit - II

Acceptance Sampling:

Introduction, Advantages and Disadvantages, Operating Characteristics curve, Producer's and consumer's risk, Quality indices for acceptance sampling plans, Types of sampling Plans-single double sequential sampling plan, Sampling plan for variables, continuous sampling plans, Skip lot sampling plans, Chain sampling plan.

Unit – III

Total Quality Management:

Introduction, Concept of Total quality, Quality function, Deployment tools for continuous quality improvement, The ISO 9000 family of standards, Six Sigma and other extensions of TQM.

Unit - IV

Reliability:

Introduction, Factor effecting Reliability, Failure and its types, Failure curve, Majors of reliability, MTBF, MTTF, Relationship b/w reliability failure rate and MTBF and its characteristics, System reliability (components in series and parallel) System reliability with stand by components, Redundancy, Operating characteristics curve, Reliability and life testing plans, Types of test, Maintainability, Availability.

Reference Books:

1. Statistical Quality control by C.Gupta.
2. Fundamental of Quality Control and Improvement by AmitavaMitra.
3. Reliability Mathematics by B.L.AmsTadter.

Name of the Program	Ph.D. Course work in Mechanical Engineering	**Program Code**	MEPH
Name of the Course	Solar Energy	**Course Code**	20MEPH11CE6
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 16 = 80 marks)

Course Objectives:

1. To reduce dependency on foreign oil and fossilfuels.
2. To improve the quality of life and alleviate rural poverty in the un-energized and off-grid areas.
3. To provide basic needs such as lights, education, entertainment and communication through affordable and reliable source of solarenergy.
4. To promote the use of sustainable, economic and least-cost decentralized electrification solutions for areas not feasible for grid connection/extension in partnership with the local government units, semi-private and privatesectors.
5. To apply solar energy technology as the enabling technology for sustainable development.
6. To apply the solar energy in the field of agriculture sector to save the crops from uneven environmentalconditions.

Course Outcomes:

By completion of course the student is able to understand/learn

1. Goodunderstandingofusingsolarenergyinlighting,storage,electricityproduction, electrification of vehicles, solar cooking etc.etc.
2. Good understanding of storage technologies, distribution grid, smart grid including sensors.regulationandcontrol,andboth“standalone”systemsandlargeintegrated distributionsystems.
3. Good understanding of national and international regulations and framework conditions for renewable energy systems. This also includes different price models andactions.
4. Profoundknowledgeinaspecialfieldsuchassolarenergy,storage,smartgrid.
5. Having approximately specialized knowledge in a field of renewable energy systems achieved through the work on a masterthesis.
6. Good knowledge about the applications of solar energy in the field of agriculture sector with specific reference to increased productivity, reduction of post-harvest losses,rapiddryingofcropstoincreasethestorageofagricultureproduce.
7. Goodknowledgeaboutpurificationofwaterusingsolarenergyusingsolardistillation process.

Unit – I

Solar Radiation

Characteristics, Earth-sun relation, Estimation on horizontal and tilted surfaces, Radiation characteristics of opaque and transparent material.

Flat Plate Collectors

Description, theory, Heat capacity effects, Time constant, Measurement of thermal performance, Air heaters.

Unit - II

Evacuated Tubular Collectors

One axis, Two axis, Solar tracking, Cylinderical, Spherical and Parabolic and Paraboloid concentrators. Composite collectors, Central receiver collectors.

Heat Storage

Sensible and latent heat storage, Chemical energy system, performance calculations.

Unit – III

Flow Systems

Natural and forced flow systems, Water heating systems for domestic, industrial and space heating requirements, Solar distillation.

Solar Heating and Cooling

Direct, indirect and isolated heating concepts, Cooling concepts, Load calculation methods, Performance evaluation methods.

Unit - IV

Solar Thermal Power Generation

Introduction, Paraboloidal concentrating systems, Cylinderical concentrating systems, Central receiver system.

Solar Refrigeration and Air Conditioning Systems

Introduction, Solar refrigeration and air conditioning systems, Solar desiccant cooling

Reference Books:

1. Solar Thermal Engineering Process by Duffie andBeckman.
2. Advanced Solar Energy Technology by H.P.Garg.
3. Solar Energy by S.P.Sukhatme.
4. Solar Energy by J.S.Hsieh.
5. Solar Thermal Engineering by P.J.Lunde.

Name of the Program	Ph.D. Course work in Mechanical Engineering	**Program Code**	MEPH
Name of the Course	Advance Heat and Mass Transfer	**Course Code**	20MEPH11CE7
Hours/Week	4	**Credits**	4
Max. Marks.	80	**Time**	3 Hours

Note: The examiner has to set a total of nine questions (two from each unit and one compulsory question consisting of short answer from all units. The candidate has to attempt one question each from each unit along the compulsory question (5 x 16 = 80 marks)

Course Objectives:

1. To study about conduction and convection in 1D and2D.
2. To study about heatexchanger
3. To study about masstransfer
4. To study aboutradiation
5. To study about different types of heatpipes

Course Outcomes:

By completion of course the student is able to understand/learn

1. Heat transfer modesin
2. Heat exchangers and theirapplications
3. Different types of heatpipes.
4. Concept of masstransfer
5. Regimes ofboiling

Unit – I

Conduction

Review of the basic laws of conduction, convection and radiation. General heat conduction equation in different co-ordinates. One dimensional steady state conduction with variable. Thermal conductivity and with internal distributed heat sources, extended surfaces review, Taperedfins,designconsiderations.Twodimensionalsteady-stateconduction,semi-infinite andfiniteflatplatesandcylinders,graphicalmethod,relaxationtechnique.Unsteadystate conduction in solids with infinite thermal conductivity, infinite thick-solids, periodic variation, solutions using Grolber's and Heisfer's charts.

Unit - II

Convection

Hydrodynamic and thermal boundary layers, differential equations, momentum and energy and their solutions, heat transfer in turbulent flow, eddy heat diffusivity, Reynold's analogy between skin friction and heat transfer. Free convection, empirical correlations, regimes of boiling, Nucleate and film boiling.

Unit – III

Heat Exchangers

Introductions,effectivenessandnumberoftransferunits,designofheatexchangers. Radiation Introduction, laws of radiation, heat exchange between black bodies and non-black bodies, shape factor algebra, Radiation shields, electrical net-work approach of radiation heat exchange.

Unit - IV

Mass Transfer

Introduction,Fick'slaw,Generalequationofmassdiffusionsteadystate,diffusionthrougha plain membrane, diffusion of water vapour through air, Mass transfer coefficient, convective masstransfer.

Heat Pipe

Introduction, Working of Heat pipe, Different types of Heat Pipe, Detail of Heat Pipe components, Advantages of Heat Pipe, Application of Heat Pipe, Performance of Heat Pipe, Limitation of Heat Pipe, Analysis and Design of Heat Pipe.

Reference Books:

1. Principles of Heat Transfer byKreith
2. Heat Transfer byHolman
3. Fundamentals of Heat and Mass-transfer by D.S.Kumar
4. Heat and mass transfer by EckertDarke.