DELHI TECHNOLOGICAL UNIVERSITY

SCHEME OF TEACHING AND EVALUATION

MASTER OF TECHNOLOGY IN COMPUTER AIDED ANALYSIS & DESIGN (CAAD)

Semester-I

S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
1	CAD 501	Numerical Methods for Engineering Applications	Core	4	3	0	2	15	25	20	40	-	24
2	CAD 503	Plasticity & Metal Forming	Core	4	3	0	2	15	25	20	40	-	
3	CAD 505	Advanced Vibration and Control	Core	4	3	0	2	15	25	20	40		
4	CAD 507	Finite Element Method	Core	4	3	0	2	15	25	20	40		
5	CAD 509	Department Elective 1	Elective	4	3/4	0	2/0	15/20	25/0	20/30	40/50	-	
6	CAD 511	Self Study (Online)	-	2	-	-	-	-	-	-	50		
7	CAD 513	Skill Enhancement Course 1(Online)	-	2	-	-	-	-	-	-	50		
		Audit Course		0	-	-	-	-	-	-	-		

Semester-II

S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
1	CAD502	Industrial Tribology	Core	4	3	0	2	15	25	20	40	-	24
2	CAD504	Product Design and Development	Core	4	3	0	2	15	25	20	40	-	
3	CAD 506	Department Elective 2	Elective	4	3/4	0	2/0	15/20	25/0	20/30	40/50	-	
4	CAD 508	Department Elective 3	Elective	4	3/4	0	2/0	15/20	25/0	20/30	40/50	-	
5	CAD510	Research Methodology & IPR (Online)	-	4	3	0	2	15	25	20	40		
6	CAD512	Skill Enhancement Course 2/Industrial Training (Online)	-	4	-	-	-	-	50	-		50	

Semester-III

S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
1	CAD601	Computational Mechanics of Materials	Core	4	3	0	2	15	25	20	40	-	16
2	CAD602	Open Elective 1 (Online)		4	3/4	0	2/0	15/20	25/0	20/30	40/50		
3	CAD603	Minor Project/Research Thesis/Patent		8	-	-	-	-	-	-	-		

Semester-IV

	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
	1	CAD604	Major Project/Research Thesis/Patent	Core	16	0	0	16	0	-	0	100	-	16

List of Electives

CAD509 Department Elective 1

CAD 5091Fracture Mechanics

CAD5092 Composite Material Technology

CAD5093 Rapid Prototyping and Tooling

CAD 5094 Product Life Cycle Management

CAD 5095 Machine Tool Design

CAD 5096 System Modelling, Simulation and Analysis

CAD 506 Department Elective 2

CAD 5061Optimization Techniques

CAD 5062 Numerical Methods in Engineering

CAD5063 Reliability Engineering

CAD 5064 Computer Aided Design

CAD 5065 Rotor Dynamics

CAD 5096 Dynamic Behaviour of Materials

CAD508 Department Elective 3

CAD5081 Smart Materials

CAD5082 Human Factors in Engineering and Biomechanical Design

CAD5083 Design for Manufacture and CIM

CAD5084 Instrumentation and Control Systems

CAD5085 Mechatronic System Design

CAD 602Open Elective 1

CAD 6021Machine Vision and Artificial Intelligence

CAD 6022Data Analytics

CAD 6023Pressure Vessels and Piping Design

CAD6024Noise and Acoustics Design

CAD 6025 Advanced Finite Element Method

SEMESTER I

CAD501:SystemModelling Simulationand Analysis

Introduction: Areviewofbasicprobabilityandstatistics,randomvariablesandtheirproperties,Estimation ofmeans variances andcorrelation.

Physical Modelling: Concept of System and environment, Continuous and discrete systems,Linearandnon-linearsystems,Stochasticactivities,StaticandDynamicmodels,Principlesofmodeling, Basic Simulation modeling, Role of simulation in model evaluation and studies,advantagesof simulation

Modelingof PhysicalSystemDynamics: AUnifiedApproach

Physical systems, Introduction to Bond graphs, Ports, Bonds and Power; Elements of Bondgraphs:1-port elements – resistor R, Stiffness C, and Inertia I, Source of Effort Se and FlowSF; 2-port elements – Transformer TF and Gyrator GY, with modulation, Junction elements 1and 0; Causality, Causality for basic 1-port and multi-ports. Derivation of System equationsfromBondgraphs in firstorderstate spaceform.

BondGraphModelingofMulti-energySystems

MechanicalSystems, Translationand rotation(about afixed axis)

System Simulation: Techniques of simulation, Monte Carlo method, Experimental nature ofsimulation,Numericalcomputationtechniques,Continuoussystemmodels,AnalogandHybrid simulation, Feedback systems, Computers in simulation studies, Simulation softwarepackages.

System Dynamics: Growth and Decay models, Logistic curves, System dynamics diagrams.Probability Concepts in Simulation: Stochastic variables, discrete and continuous probabilityfunctions,RandomNumbers,GenerationofRandomnumbers,Variancereductiontechniques,Determinationoflengthof simulation runs.

SimulationofMechanicalSystems:BuildingofSimulationmodels,Simulationoftranslationaland rotationalmechanical systems,Simulation ofhydraulicsystems.

Labcontents

RecommendedBooks:

1. **SystemSimulation**-GeoffreyGordon-PrenticeHall
2. **SystemSimulation:TheArtandScience**-RobertE.Shannon-PrenticeHall
3. **SystemModellingandControl**-J. SchwarzenbachandK.F.Gill Edward Arnold
4. **Modelling and AnalysisofDynamicSystems**-CharlesMCloseandDeanK.Frederick HoughtonMifflin
5. **SimulationofManufacturing**-AllanCarrieJohnWiley&Sons
6. **BondGraphinModeling,SimulationandFaultIdentification**-AmalenduMukherjee,RanjitKarmakar,ArunSamantary-I.K.Int. Pub. House

CAD 503:ComputationalMechanics ofMaterials

Analysisofdeformationandmotion

Motionofacontinuum,deformationgradient,polardecomposition,objectivityoftensorfields,measuresof strain, rate of deformation and vorticity.

Transporttheorem,balancelaws

Massconservation,momentumbalanceequations,Cauchystresstensor,Conjugatestresstensors,stress rates.

Generalconstitutivetheory

Materialsymmetry,invariancerequirements,Cauchyelasticmaterial,Greenelasticmaterial.

Analysisoflargedeformationandstrain in3-Delasticcontinuum

Formulationofboundaryvalueproblems: examples.

Variationalprinciplesandconservationlaws

Virtualworkprincipleforlargedeformationproblems.Principleofstationarypotentialenergy,complementaryandmixed variationalprinciples,variational principleswithconstraints.

RecommendedBooks

1. **ContinuumMechanics**,GurtinandAnand
2. **ContinuumMechanics**, J. N. Reddy
3. **Nonlinearelasticdeformations**,R.W.Ogden

CAD505: Product Designand Development

Stagesin design process

Introductiontovariousstagesofthedesignprocess:Formulationofproblem,Generationofalternatives,Evaluation,Guided Redesign. Case study.

Productlifecycle

New product introduction: early introduction, increased product life. Life cycle management tools:Systemintegration,QFD,Houseofquality,Pugh'smethod,Pahl andBeitzmethod.Casestudies.

Valueengineering

Introduction, nature and measurement of value.Value analysis job plan.Creativity and techniques ofcreativity.Valueanalysis test.Case studies.

Concurrent/reverseengineering

Introduction,basicprinciples,components,benefitsofconcurrentengineering.Conceptofreverseengineering

Materialselection

Materials in design.The evolution of engineering materials. Design tools and material data. Function,material, shape and process. Material selection strategy, attribute limits, selection process, computeraidedmaterialselection. Case studies.

Processselection

Introduction.Processclassification:shaping,joiningandfinishing.Systematicprocessselection.Ranking,processcost. Computer– aided processselection

Designformanufactureandassembly

DesignforManufactureandAssembly(DFMA).ReasonsfornotimplementingDFMA.AdvantagesofDFMAwithcasestudies.Designfeaturesandrequirementswithregardtoassembly,production.Designfor Manufacture in relation to any two manufacturing processes: machining and injection molding.Need,objectives.

Designfor "X"

Introduction.Designfor:Safety,packagingandstorage,quality,reliability,energyconservation,environment,aesthetics,ergonomics,maintenance,recyclabilityand disposal. Casestudies.

Patents,liabilityandethics

Introduction.Protectingyourdesign:patents,copyright,basictoolsofdesignprotection.Liabilityissuesinproductdesign. Ethicalconsiderations.Examples/casestudies.

RecommendedBooks:

1. **ProductDesignandDevelopment**,"KarlT.Ulrich,StevenD.Eppinger"McGrawHill
2. **IntegratedProductandProcessDevelopment**, "JohnM.Usher,UtpalRoyandH.R.Parasaei
3. **ProductDesignforManufactureandAssembly**,"G.Boothroyd,P.DewhurstandW.Knight"MarcelDaker
4. **EngineeringDesignandDesignforManufacturing**:Astructuredapproach,"JohnR.DixonandCorrodoPoli"Field Stone Publishers, USA.
5. **MaterialSelectioninMechanicalDesign**,"M.F.Ashby"Elsevier.

CAD507:CompositeMaterialTechnology

Introduction to Composite Materials: Definition, Classification, Types of matrices materialand reinforcements, Characteristics & selection, Fiber composites, laminated composites,Particulatecomposites, Prepegs, and sandwichconstruction.

Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number ofelastic constants, Derivation of nine independent constants for orthotropic material, Two -dimensional relationship of compliance and stiffness matrix. Hooke's law for twodimensionalangle lamina, engineering constants - Numerical problems.Invariant properties.Stress-Strainrelationsforlamina of arbitraryorientation, Numerical problems.

MicroMechanicalAnalysisofaLamina: Introduction,Evaluationofthefourelasticmoduli,Ruleofmixture, Numerical problems.

BiaxialStrengthTheories: Maximumstresstheory,Maximumstraintheory,Tsa-Hilltheory,Tsai,Wu tensortheory,Numerical problems.

MacroMechanicalAnalysisofLaminate: Introduction,code,Kirchoffhypothesis,CLT,A,B, and D matrices (Detailed derivation) Engineering constants, Special cases of laminates,Numericalproblems.

Manufacturing: Lay up and curing - open and closed mould processing, Hand lay, Uptechniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming,Injection moulding, Cutting, Machining and joining, tooling, Quality assurance, Introduction,materialqualification, Types of defects, NDT methods.

Application Developments: Aircrafts, missiles, Space hardware, automobile, Electrical andElectronics,Marine,Recreational andsportsequipment-futurepotentialof composites.

MetalMatrixComposites: ManufacturingofMMC,Reinforcementmaterials,Types,Characteristicsand selection, Basemetals,Selection, Applications.

RecommendedBooks:

1. **CompositeMaterials handbook,** MeinSchwartzMcGrawHillBookCompany,1984.
2. **Mechanicsofcomposite materials,** AutarK.KawCRCPressNewYork.
1. **Mechanicsof CompositeMaterials,**RoberM.JonessMc-GrawHillKogakusha Ltd.
2. **StressanalysisoffiberReinforcedCompositeMaterials,**MichaelW,HyerMc-GrawHillInternational.
3. **CompositeMaterialScienceandEngineering,**KrishanK.ChawlaSpringer.
4. **FibreReinforcedComposites,** P.C.MallikMarcelDecker.

CAD5091:Fracture Mechanics

Fracture mechanics principles: Introduction and historical review, Sources of micro andmacro cracks. Stress concentration due to elliptical hole, Strength ideal materials, Griffith'senergy balance approach. Fracture mechanics approach to design. NDT and Various NDTmethodsused in fracturemechanics, Numerical problems.

TheAirystressfunction:Complexstressfunction.Solutiontocrackproblems.Effectoffinitesize.Specialcases,Ellipticalcracks,Numericalproblems.Plasticityeffects,Irwinplasticzonecorrection. Dugdale approach. The shape of the plastic zone for plane stress and plane straincases,Plastic constraint factor.TheThickness effect,numerical problems.

Determination of Stress intensity factors and plane strain fracture toughness:Introduction,analysisandnumericalmethods,experimentalmethods,estimationofstressintensityfactors.Planestrainfracturetoughnesstest, TheStandardtest.Sizerequirements.Non-linearity.Applicability.Theenergyreleaserate,Criteriaforcrackgrowth.Thecrackresistance(Rcurve).Compliance, Jintegral.Tearingmodulus.Stability.

Elastic plastic fracture mechanics : Fracture beyond general yield. The Crack-tip openingdisplacement.The Use of CTOD criteria.Experimental determination of CTOD.ParametersaffectingthecriticalCTOD.Useof J integral.Limitation ofJintegral.

Dynamics and crack arrest: Crack speed and kinetic energy. Dynamic stress intensity andelasticenergyreleaserate.Crackbranching.Principlesofcrackarrest.Crackarrestinpractice.Dynamicfracturetoughness, Testingforfracture,

Fatigue crack propagation and applications of fracture mechanics: Crack nucleation andgrowth andthe stress intensity factor. Factorsaffecting crackpropagation. , fatigue lifeprediction,Parislaw,statisticalanalysis,variableamplitudeserviceloading,Meanstoprovidefail-safety, Required information for fracture mechanics approach, Mixed mode (combined)loading and design criteria. Fracture of composite materials. Use of FEM softwares likeABAQUSforanalysis ofbodies containing cracks.

LabContents

RecommendedBooks:

1. **ElementaryEngineeringFractureMechanics**-DavidBroek,Noordhoff.
2. **FractureMechanics-FundamentalandApplication**-Anderson,T.LCRCpress1998.
3. **Engineeringfracturemechanics** -S.A.Meguid,Elsevier.
4. **Fractureof EngineeringBrittleMaterials,**AppliedScience-Jayatilake, London.
5. **FractureandFatigue ControlinStructures** -RolfeandBarsom,,PrenticeHall.
6. **Introductiontofracturemechanics** -KarenHellan,McGrawHill.
7. **FundamentalsofVfracturemechanisms**-Knott,Butterworths.
8. **Fracture**–ed. Liebowitz,VolumeII.
9. **IntroductiontoFractureMechanics**,PrashantKumar

CAD5092:Theory of Elasticity and Plasticity

Introduction:

Analysis of stress and strain; Equilibrium; Specification of stress at a point. Principal stresses andMohr's diagram in three dimensions. Boundary conditions .Stress components on an arbitrary plane,Stress invariants, Octahedral stresses, Decomposition of state of stress, compatibility and constitutiveequations,Deformation**,**StrainDisplacementrelations,Straincomponents,Thestateofstrainatapoint,Principalstrain,Straintransformation,Stress-StrainRelationsandtheGeneralEquationsofElasticity**,**Saint -Venant's principle,Principle ofsuperposition andreciprocaltheorem

ElastcityProblems

Airy's stress function, investigation for simple beam problems. Bending of a narrow cantilever beamunderendload,simplysupportedbeam withuniform load,UseofFourierseriestosolvetwodimensional problems. Two Dimensional Problems in Polar Co-Ordinates**:** General equations, stressdistribution symmetrical about an axis, Pure bending of curved bar, Strain components in polarcoordinates,Rotatingdiskandcylinder,Concentratedforceonsemi-infiniteplane,Stressconcentrationaroundacircularholeinaninfiniteplate.Axsymmetricproblems,ellipticalhole.IntroductiontothreeDimensional Problems, Analysis of stress and strain in 3-d, stress , ellipsoid, variational methods,Castigliano'stheorems.Anisotropicelasticity,finite deformationelasticity.

IntroductiontoPlasticity:
Definition and scope of the subject, Brief review of elasticity, Octahedral normal and shear stresses,Spherical and deviatric stress, Invariance in terms of the deviatoric stresses, Representative stress.Idealisedstress-straindiagramsfordifferentmaterialmodels,Engineeringandnaturalstrains,Mathematicalrelationshipsbetweentruestressandtruestrains,Cubicaldilation,finitestrainscoefficientsOctahedralstrain, Strain rate andthestrainrate tensor.

YieldCriteriaforMaterials
Yield criteria for ductile metal, Von Mises, Tresca, Yield surface for an Isotropic Plastic materials,Stressspace,ExperimentalverificationofYieldcriteria,Yieldcriteriaforananisotropicmaterial.Hills'criterion, Plastic stress-strain relations, PrandtlRoeuss Saint Venant, Levy - Von Mises, Experimentalverificationofthe Prandtl-Rouss equation,Yield locus,Symmetryconvexity,Normalityrule.,

Upperandlowerboundsolutions
Upper and lower bound theorems and and corollaries. Application to problems: Uniaxial tension andcompression,bendingofbeams,Torsionofrodsandtubes,Simpleformsofindentationproblemsusingupper bounds. Slip line theory, Basic equations for incompressible two dimensional flow, continuityequations, Stresses in conditions of plain strain convention for slip-lines, Geometry of slip lines,Propertiesof slip lines.

LabContents

RecommendedBooks:

1. **EngineeringPlasticity-TheoryandApplicationtoMetalFormingProcess-**R.A.C..Slater,McMillanPressLtd.
2. **TheoryofPlasticityandMetalformingProcess**-SadhuSingh,KhannaPublishers,Delhi.
3. **PlasticityforMechanical Engineers-**JohnsonandMellor.

CAD5093:RapidPrototyping and Tooling

Introduction: Historical developments, Fundamentals of RP Systems and its Classification,Rapid prototyping process chains, 3D modeling and mesh generation, Data conversion andtransmission.

RP Systems: Liquid polymer based rapid prototyping systems, Teijin Seikis' solid form andother similar commercial RP systems, Solid input materials based rapid prototyping systems,laminated object manufacturing (LOM) and fused deposition modelling systems etc., Powerbased rapid prototyping systems, selective Laser sintering, Soligen Diren's shell productioncasting(DSPC),Fraunhofer'smultiphasejetsolidification(MJS)andMIT's3Dprinting(3DP)etc.

RPDatabase: Rapidprototypingdataformats,STLformat,STLfileproblems,STLfilerepair,Network based operations, Digital inspection, Data warehousing and learning from processdata.

RPApplications: Developmentofdiesformoulding,RPapplicationsindevelopingprototypes of products, application in medical fields, Development of bone replacements andtissues,etc., RP materials andtheir biological acceptability.

RecommendedBooks:

1. **RapidPrototypingofDigitalSystems:A TutorialApproach**-HamblenJamesOKluwerAca
2. **RapidPrototyping:PrinciplesAndApplications**-KaiChuaCheeWorld Scie
3. **RapidSystemPrototypingWithFpgas:AcceleratingTheDesignProcess**-RCCoferNewnes
4. **RapidPrototypingofDigitalSystems**-JamesOHamblenSpringer

CAD5094:ProductLifeCycle Management

Introduction: ExtensivedefinitionofConcurrentEngineering(CE),CEdesignmethodologies, Review of CE techniques like DFM (Design for manufacture), DFA (Designforassembly),QFD(Qualityfunctiondeployment),RP(Rapidprototyping),TD(Totaldesign), for integrating these

technologies, Organizing for CE, CE tool box, Collaborativeproductdevelopment.

Use of Information Technology: IT support, Solid modeling, Product data management,Collaborative product Commerce, Artificial Intelligence, expert systems, Software hardwarecomponentdesign.

Design Stage: Lifecycle design of products, Opportunities for manufacturing enterprises,Modality of concurrent engineering design, automated analysis Idealization control, CE inoptimalstructural design,Real timeconstraints.

NeedforPLM: ImportanceofPLM,ImplementingPLM,ResponsibilityforPLM,Benefitstodifferent managers, Components of PLM, Emergence of PLM, Lifecycle problems to resolve,Opportunitiestoseize. Roleofsustainability, Sustainableproduct lifemanagement.

ComponentsofPLM: ComponentsofPLM,Productlifecycleactivities,Productorganizationalstructure,Humanresourcesinproductlifecycle,Methods, techniques,Practices,Methodologies, Processes, System components in lifecycle, slicing and dicing the systems,Interfaces,Information,Standards.

Block chain concept in product lifeRecommendedBooks:

1. **IntegratedProductDevelopment**M.M.AndersonandLHeinIFSPublications
2. **DesignforConcurrentEngineering** J.Cleetus CEResearchCentre,Morgantown
3. **ConcurrentEngineeringFundamentals:IntegratedProductDevelopment**-PrasadPrenticehallIndia
4. **ConcurrentEngineeringinProductDesignandDevelopment**-IMoustaphaNewAgeInternational
5. **ProductLifecycleManagement**-JohnStarkSpringer-Verlag,UK
6. **ProductLifecycleManagement**-MichaelGrievesMcGrawHill
7. **ConcurrentEngineering**:**AutomationtoolsandTechnology-**AndrewKusiakWileyEastern

CAD5095:MachineToolDesign

Designapproach

Designrequirementsofmachinetools.Adesignapproachformachinetools.Identificationandquantificationofobjectivesandconstraintsinmachinetoolde sign.Kinematicsofmachinetooldrives,stepped and stepless speed regulation,

Powerrequirements

Estimationofpowerrequirementsandselectionofmotorformetalcuttingmachinetoolspindles.

1. Gearboxdesign
2. Designofgearbox,spindleand guide-ways.

Structuraldesign

Principles of design of structural components, namely, head stock, tail stock, carriage, table,knee, column and over arms to achieve desired static & fatigue strength, stiffness, dynamiccharacteristicsandotherrequirements.Exercisesonthedesignofmachinetoolsusingexisting CADsoftwarepackages.Hydraulicdrivestestingof machinetools.Dynamicsacceptancetests,Dampingin machinetools Moderntrends in machinetool design,transfer machines.

CNCmachinedesign

IntroductiontocomputerintegratedmanufacturingsystemsandCNCmachinetools.

DesignofCNCsystems

Design/selection of linear motion systems, ball, screws, CNC feedback devices, controllers,feed drives and servomotors for CNC machine tools.Recent developments in CNC and othermachinetools.

RecommendedBooks:

1. **DesignofDevicesandSystems**,"WilliamH.MiddendorfandRichardH.Engelmann"CRCPress.
2. **Computernumericalcontrolofmachinetools**,"G.E.Thyer"HeinemannProfessionalPublishing.
3. **MachineDesignFundamentals:AMechanicalDesigners'Workbook**,JosephEdwardShigleyandCharles R. Mischke, Mcgraw Hill.
4. **NumericalControlandComputeraidedmanufacture**,"Kundra,Rao,Tiwari"TataMcGrawHill.

SEMESTER II

CAD502:FiniteElementMethod

IntroductiontoFiniteElementMethod

Engineering Analysis, History, Advantages, Classification, Basic steps, Role of finite elementanalysisincomputer-aideddesign.,MathematicalPreliminaries,Differentialequationsformulations, Variational formulations, weighted residual method, Virtual work principle,Classification, boundary conditions and characteristics of second order partial differentialequations, boundary value problems, eigenvalues problems,orthogonal matrices, similaritytransformation.One-DimensionalElements-AnalysisofBarsandTrusses BasicEquationsandPotentialEnergyFunctional,1-DBarElement,Shapefunctions,Stiffnessmatrix,AssemblyProcedure, BoundaryConditions,2-D truss element.

Two-Dimensional Elements-Analysis of Plane Elasticity Problems: Linear Triangular andQuadrilateral Elements, Shape functions for Higher Order Elements,Lagrange elements,Serindipity elements, Isoparametric elements, Numerical integration, convergence criteria,discretizationerror,convergencerate,patch test,conforming, non-conformingelements.

Axi-symmetric Solid Elements-Analysis of Bodies of Revolution under axi-symmetricloading: AxisymmetricTriangularandQuadrilateral RingElements. Three-DimensionalElements-ApplicationstoSolidMechanicsProblems, TetrahedralElements,HexahedralElements.

Beam Elements-Analysis of Beams and Frames: Beam elements, Reduced integration,Elementsbased onBernoulli and Timoshenkotheoryofbeams.

HeatTransfer*And*FluidFlow:Steadystateheattransfer,heatconductiongoverningequation, boundary conditions, Functional approach for heat conduction, Galerkin approachfor heat conduction, heat flux boundary condition, Basic differential equation for fluid flow inpipes andaroundsolid bodies.

Dynamic Considerations: Formulation for point mass and distributed masses, Consistentmassmatrix, Lumped mass matrix, Evaluationofeigenvalues andeigenvectors.

Electromagnetic simulation using FEM. Use of softwares like Abaqus and Ansys.LabContents

RecommendedBooks:

1. ChandrupatlaT.R.,"**FiniteElementsinengineering"-**2ndEdition,PHI,2007.
2. LakshminarayanaH.V.,"**FiniteElementsAnalysis"**–ProceduresinEngineering,UniversitiesPress,2004
3. RaoS.S."**FiniteElementsMethodinEngineering"-**4thEdition,Elsevier,2006
4. P.Seshu,"**TextbookofFiniteElement Analysis"**-PHI,2004.
5. J.N.Reddy,"**FiniteElementMethod"-**McGraw-HillInternationalEdition.BatheK.J.FiniteElementsProcedures,PHI.
6. Cook R.D., et al."**Concepts andApplication of Finite ElementsAnalysis"-** 4thEdition, Wiley &Sons,2003.
7. FiniteElementMethod,K.J.Bathe,PrenticeHallofIndia
8. FEM,ZienkiewiczandTaylor

CAD504:ComputerAided Design

IntroductionandReview of CAD

Introduction and Overview, Need and Scope of computer aided Machine design, Role ofGeometric modelling, Principles of interactive Computer graphics, Overview of hardwareavailablefor usein CAD.

ThreeDimensionalTransformations

Geometric transformations & Axonometric, Diametric, Trimetric and oblique Projections,Windowing&View porting.

Geometric Modelling and Applications: Introduction, wire frame models and entities, curverepresentations,parametricrepresentationofanalyticalcurves,syntheticcurves,Beziercurves,B-splinecurves,Rationalcurves,curvemanipulations,designandengineeringapplications.

Solidmodelling

Half spaces, Boundary representation (B-rep), Constructive solid geometry (CSG), Sweeprepresentation,Analytical solid making, and solidmanipulation.

AdvancesinComputerAidedEngineeringDesign

Failure considerations in designing, Robust design, Reliability, Ergonomic considerations inDesign, Feature based design, Design for manufacturing, Design for Automation, CAD ofcomplexEngineeringSystems.

Labcontent

RecommendedBooks:

1. **ComputerGraphics** -DHearn&MPBaker-PrenticeHall
2. **CAD/CAMTheoryandPractice**-IbrahimZeid&RSivasubramanian-TataMcGraw-Hill
3. **CAD/CAM- Principlesand Applications**-PNRao TataMcGraw-Hill
4. **ComputerAidedEngineeringDesign**-ASaxenaandBSahay-Anamya Publications
5. **Mathematical Elements for Comp. Graphics**- D F Rogers and J A Adams- McGraw-HillInternational
6. **CAD/CAM**-HPGrooverandEWZimmers -PrenticeHall
7. RadhakrishnanandKothandaraman,"**ComputerGraphicsandDesign**"DhanpatRai1997.
8. RogersDavidF"**ProceduresElementsforComputerGraphics**"secondEd.TataMcGraw Hill 2001

CAD 5061:Optimization TechniquesinDesign

Introduction to Optimization - Introduction, Engineering Applications, Problem Statement,Classificationofoptimization problems.

ClassicalOptimizationtechniques-UnconstrainedOptimization:OptimizingSingle-VariableFunctions,conditionsforLocalMinimumandMaximum,OptimizingMulti-VariableFunctions.ConstrainedOptimization:OptimizingMultivariableFunctionswithEqualityConstraint:LagrangeMultipliersMethod.Constrained MultivariableOptimizationwithinequalityconstrained:Kuhn-TuckerNecessaryconditions,Kuhn–TuckerSufficientConditions.

GoalProgramming: Formulationandsolutionofgoalproblems.

Non-Linear Programming- One-Dimensional Methods: Elimination Methods, InterpolationMethods, Direct Root Methods; Quasi-Newton Method, Secant Method. Docotomous searchmethod, Fabonacci method, Golden section method, Unconstrained Optimization Techniques:Direct search methods, Descent Methods. Constrained Optimizations: Direct and Indirectmethods.

Dynamic Programming: Concept of Dynamic Programming, Multi stage Decision Process,CalculusMethod and TabularMethod.

IntegerProgramming –BranchandboundMethod,CuttingPlaneMethod.

IntroductiontoAdvancedOptimizationTechniques-GeneticAlgorithms(GA),SimulatedAnnealing, Particle Swarm Optimization (PSO), Ant

Colony Optimization (ACO), NeuralNetwork,SeparableProgramming, StochasticProgramming, MonteCarloSimulation.

RecommendedBooks:

1. Taha,H.A.,"**OperationsResearch**" PHI
2. OptimizationofEngineeringDesign,"Deb,K."PHI
3. OperationsResearch,"D.S.Hira,P.K.Gupta"S.Chand
4. Optimizationtechniques,"Rao"NewAgeinternational
5. IntroductiontoOptimalDesign,JasbirSinghArora,McGrawHillInternational

CAD5062:NumericalMethodsinEngineering

***Approximations*:** Accuracy and precision, definitions of round off and truncation errors, errorpropagation.

***Algebraicequations*:**Formulationandsolutionoflinearalgebraicequations,Gausselimination, LU decomposition, iteration methods (Gauss- Seidal), convergence of iterationmethods,eigen values and eigen vectors
Interpolation methods: Newton's divided difference, interpolation polynomials,Lagrangeinterpolationpolynomials.

***DifferentiationandIntegration*:**Highaccuracydifferentiationformulae,extrapolation,derivativesof unequallyspaced data, Gaussquadratureand integration.

***Transform techniques**:* Continuous Fourier series, frequency and time domains, Laplacetransform, Fourier integral and transform, Discrete Fourier Transform (DFT),Fast FourierTransform(FFT).

Differential equations**:* Initial and boundary value problems, eigenvalues problems, solutionstoellipticalandparabolicequations,partialdifferentialequations.Regressionmethods**:*Linearandnon-linear regression,multiple linearregression,generallinear leastsquares.

***Statistical methods**:* Statistical representation of data, modeling and analysis of data, test ofhypotheses.

Solutiontopracticalengineeringproblemsusingsoftwaretools

RecommendedBooks*:*

1. Schilling R.JandHarrisSL,"**AppliedNumericalMethodsforEngineeringusingMatLaband C**", Brooks/Cole PublishingCo., 2000.
2. ChapraSCandCanaleRP,"**NumericalMethodsforEngineers**",McGrawHill,1989.
3. Hines,W.WandMontrogmery,"**ProbabilityandStatisticsinEngineeringand ManagementStudies"**,JohnWilley,1990.
4. SanthoshK.Gupta,"**NumericalMethodsforEngineers**",NewAgeinternationalpublishers, 2005.

CAD5063:ReliabilityEngineering

Introduction:

Systemconceptsinreliability,availabilityandmaintainability(RAM)Engineering,PracticalapplicationsofRAMEngineeringtosystems,productsandprocesses;Concepts,termsanddefinitions;Failureratefunction,Probabilitydensityfunction,Cumulativedistributionfunction,reliabilityfunction,Meantime to failure (MTTF), MTBF,MTTRetc.

Fundamentalsofreliability:

Failure distributions; Exponential, Weibull, Normal and Lognormal; Constant failure rate model andtimedependentfailure models

Systemreliabilityassessment:

Series, Parallel, Combined series-parallel configurations; Cut sets and path sets approach, fault treeanalysis (FTA); State dependent systems; Markov analysis, load sharing system, standby system,degradedsystem, Monte Carlosimulation.

DesignforReliabilityandreliabilityimprovement:

Reliability specifications and system measurements, reliability allocation ; exponential case, optimalallocations,arnicamethod,AGREEmethod,Varioustypesofredundancies;activeandpassiveredundancy,k-out-of-n-redundancy,standbyredundancy,optimization,reliability-cost tradeoff.

Availabilityandmaintainability:

Point,missionandsteadystateavailability;Availabilityassessment,Maintainabilityanditsassessment;Maintenancepolicies:individualpolicy,Planned,preventiveandconditionbasedmaintenance;Opportunisticmaintenancepolicy.

Designformaintainability:

Maintenance requirements, measurements and specifications, fault diagnosis, failure mode and effectanalysis (FMEA), Parts standardization and interchangeability, modularization, accessibility, repairversus replacement,proactivemaintenance,maintainabilityprediction anddemonstration.

RecommendedBooks:

1. EbelingCharlesE.,"**AnintroductiontoReliabilityandMaintainabilityEngineering**",TataMcGraw-Hill PublishingCo. Ltd.,NewDelhi,2000.
2. Srinath,L.S."**ReliabilityEngineering**",AffiliatedEast–WestPressLtd.,NewDelhi,2006.
3. Dhillon,B.S.,"**EngineeringMaintainbility**",PrenticeHallofIndia,NewDelhi,2000.
4. Blanchard,Benjamin,S.,"**LogisticsEngineeringandManagement**",PrenticeHallofIndia,NewDelhi,2006.

CAD 5064: Engineering Tribology and Bearing Design

Introduction

History of evolution and definition, Lubrication, wear, cost of friction and wear. Lubricantsand their physical properties, viscosity index, Reynolds equation, Derivation and physicalsignificance,standard reduction forms ofReynolds equation.

FrictionandWear

Law of sliding friction, concept of adhesion. Taylor's model of friction, Measurement offriction. Laws of wear, Abrasive, Erosive and Cavitation wear: Introduction, abrasive wear,mechanisms of abrasive wear, mechanisms of erosive wear, effect of impingement angle andimpact speed on erosive wear rate. Effect of particle shape, hardness, size and flux rates onerosivewearrate.Erosivewearbyliquid, Cavitationwear,mechanism ofcavitationwear.

AdhesionandadhesivewearMechanismofadhesion.Corrosiveandoxidativewear:Introduction, corrosivewear, transition between corrosiveand adhesivewear, synergismbetween corrosive and abrasive wear, oxidative wear, kinetics of oxide film growth on metalsathigh and low temperatures.

Fatigue wear: Introduction, fretting wear, melting wear, wear due to electrical discharges,diffusivewear, impact wear. Sitiback number,curveand law.

Lubrication

Solid lubrication and surface treatments: Introduction, Lubrication by solids, lubrication bylamellarsolids.HydrostaticLubrication,formationoffluidfilm,pressuredistributionandflow,normalloadcomponent,frictionaltorqueandpowerloss. Introductiontogaslubrication.Thermohydrodynamiclubrication:governingequationandboundaryconditions.

BearingDesign

Designof bearing,Clearanceinjournalbearing,minimumfilmthickness,sommar-fieldnumber, oil grooves and flow of oil in axial and circumferential grooves cavitations andturbulenceinoilbearings.Heatgenerationandcoolingorbearinghydrostaticanddynamicandtheirapplications in machinetools. Design ofair bearingand other gas bearing.
Smartbearingand bearingwith iot.

RecommendedBooks:

1. **EngineeringTribology**-Gwidon W.Stachowiak andAndrew W.Batchelor
2. **Fundamentalsof fluidfilmlubrication**-BernardJ.Hamrock
3. **IndustrialTribology**,Dr.B.S.Prabhu,McGrawHill

CAD5065:Rotor Dynamics

Fluid Film Lubrication: Basic theory of fluid film lubrication, Derivation of generalizedReynolds equations, Boundary conditions, Fluid film stiffness and Damping coefficients,Stabilityanddynamicresponseforhydrodynamic journalbearing,Twolobejournalbearings.

Stability of Flexible Shafts: Introduction, equation of motion of a flexible shaft with rigidsupport,Radialelasticfrictionforces,Rotaryfriction,frictionIndependentofvelocity,frictiondependent on frequency, Different shaft stiffness Constant, gyroscopic effects, Nonlinearproblemsof largedeformation applied forces,instabilityof rotorsin magneticfield.

CriticalSpeed: Dunkerley'smethod,Rayleigh'smethod,Stodola'smethod.

RotorBearingSystem: Instabilityofrotorsduetotheeffectofhydrodynamicoillayerinthebearings,support flexibility,Simplemodel withoneconcentratedmassatthecenter.

Turbo-rotorSystemStabilitybyTransferMatrixFormulation: Generalturbo-rotorsystem, development of element transfer matrices, the matrix differential equation, effect ofshearandrotaryinertia, the elasticrotors supported inbearings, numerical solutions.

Turbo-rotorSystemStabilitybyFiniteElementFormulation:Generalturbo-rotorsystem,generalizedforcesandco-ordinatessystemassemblyelementmatrices,Consistentmassmatrixformulation, Lumped mass model, Linearised model for journal bearings, System dynamicequations Fix stability analysis non dimensional stability analysis, unbalance response andTransientanalysis.

BladeVibration: Centrifugaleffect,Transfermatrix andFiniteelement,approaches.

RecommendedBooks:

1. **PrinciplesofLubrication-**Cameron Longmans.
2. **Non-conservativeproblemsoftheTheoryofelasticstability**-Bolotin,Pergamon.
3. **MatrixmethodsofElastomechanics**-Peztel,Lockie,McGrawHill.
4. **VibrationProblemsinEngineering**-Timosenko,Young,VonNostrand5.Zienkiewicz,"TheFinite Element Method",McGrawHill.
5. **RotorDynamics-**J.S.Rao
6. **RotorDynamics**-Tondel

CAD5081:SmartMaterials

OverviewofSmartMaterials,StructuresandProductsTechnologies.

SmartMaterials(PhysicalProperties)piezoelectricmaterials,materials,magnetostrictiveelectrostrictivematerials,magnetoelectricmaterials.magnetorheologicalfluids,electrorheologicalfluids,applicationsofelectroreologicalfluids,shapememorymaterials,fiber-opticsensors.

SmartSensor,ActuatorandTransducerTechnologiessmartsensors:accelerometers;forcesensors; load cells; torque sensors; pressure sensors; microphones; impact hammers; MEMSsensors;NEMSsensors,sensorarrayssmartactuators:displacementactuators;forceactuators;poweractuators;vibrationdampers;shakers;fluidic pumps;motorssmarttransducers:ultrasonictransducers; sonictransducers; air transducers.

Measurement, Signal Processing, Drive and Control Techniques quasi-static and dynamicmeasurement methods; signal-conditioning devices; constant voltage, constant current andpulse drive methods; calibration methods; structural dynamics and identification techniques;passive,semi-active andactivecontrol;feedbackandfeedforwardcontrolstrategies.

Design, Analysis, Manufacturing and Applications of Engineering Smart Structures andProducts : Case studies incorporating design, analysis, manufacturing and applicationissuesinvolvedinintegratingsmartmaterialsanddeviceswithsignalprocessingandcontrolcapabilitiestoengineering smartstructuresandproducts.Emphasisonstructures,automationandprecisionmanufacturingequipment,automotives,consumerproducts,sportingproducts,computerandtelecommunicationsproducts,medicalanddentaltoolsandequipment.

RecommendedBooks:

1. **SmartMaterialsandStructures-**M.V.GandhiandB.SoThompson,ChapmanandHall,London;New York, 1992 (ISBN: 0412370107).
2. **SmartStructuresandMaterials-**B.Culshaw,ArtechHouse,Boston,1996(ISBN :0890066817).
3. **SmartStructures:AnalysisandDesign-**A.V.Srinivasan,CambridgeUniversityPress,Cambridge;New York, 2001 (ISBN: 0521650267).
4. **Electroceramics:**Materials,PropertiesandApplications-A.J.MoulsonandJ.M.Herbert.JohnWiley&Sons,ISBN:0471497429
5. **PiezoelectricSensories:**Force,Strain,Pressure,AccelerationandAcousticEmissionSensors.MaterialsandAmplifiers,Springer, Berlin;NewYork,2002(ISBN:3540422595).
6. **PiezoelectricActuatorsandWtrasonicMotors-**K.Uchino,KluwerAcademicPublishers,Boston,1997 (ISBN: 0792398114).
7. **HandbookofGiantMagnetostrictiveMaterials-**G.Engdahl,AcademicPress,SanDiego,Calif.; London, 2000 (ISBN: 012238640X).
8. **ShapeMemoryMaterials-**K.OtsukaandC.M.Wayman,CambridgeUniversityPress,Cambridge;New York, 199~ (ISBN: 052144487X).

CAD5082: Human factors Engineering and Biomechanical Design

Introduction

Humanfactorsandsystems.Humanfactorsresearchmethodologies

InformationInput

Information Input and Processing, Text, Graphics, Symbols and Code, Visual Display ofDynamicInformation,Auditory,TactualandOlfactoryDisplays,SpeechCommunications

HumanOutputandControl

Physical Work and Manual Materials Handling Motor Skills, Human Control of systems,Controlsand Data Entrydevices, Handtools and devices,

WorkplaceDesign

AppliedAnthropometry,Work-spacedesignandSeating,ArrangementofComponentswithinaPhysical Space,Interpersonal Aspects ofWorkplaceDesign

EnvironmentalConditions

Illumination,Climate,Noise,Motion

HumanFactorsApplications

Human Error, Accidents and Safety, Human Factors and the Automobile. Human Factors inSystemsdesign

BiomechanicalDesign

Biomechanicalsystems,Biomechanicalanalysis,NaturaldesignvsMechanicalDesign,Designinganddevelopingequivalentmechanicalsystems,Casestudiesandanalysis,Biomechanicalmodeling and simulation.

RecommendedBooks:

1. MarkSanders,ErnestMcCormick,**HumanFactorsInEngineeringandDesign**,7thedition,McGraw-HillInternational Editions.
2. Y.C.Fung,"**BiomechanicsVol.1,2,3**."

CAD5083:Design forManufactureandCIM

1. Effect of Materials And Manufacturing Process On Design: Major phases of design.Effect of material properties on design, Effect of manufacturing processes on design. Materialselectionprocess.

2. ToleranceAnalysis: Processcapability,mean,variance,skewness,kurtosis,Processcapability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometric tolerances, Surfacefinish, Review of relationship between attainable tolerance grades and different

machiningprocess.Cumulativeeffect oftolerance-Surefitlaw and truncatednormal law.

3. Selective Assembly: Interchangeable part manufacture and selective assembly, Grouptolerance of mating parts equal, Model total and group tolerances of shaft equal. Control ofaxialplay-Introducingsecondarymachiningoperations,Laminated shims,examples.

4. DatumFeatures: Functionaldatum,Datumformanufacturing,Changingthe datum.

5. DesignConsiderations: Designofcomponents withcastingconsideration.Pattern,Mould,andPartingline.CoredholesandMachinedholes.Identifyingthepossibleandprobablepartingline.Castingrequiringspecial sand cores.Designingto obviate sandcores.

6. Component Design: Component design with machining considerations like design forturning,milling, Drillingand otherrelated processes includingfinishingoperations.

7. True positional theory: Comparison between co-ordinate and conventional method offeaturelocation.Toleranceandtruepositiontolerancingvirtualsizeconcept,Floatingandfixedfasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functionalgauges,Paper layout gauging.

8. DesignofGauges: Designofgaugesforcheckingassemblewithemphasisonvarioustypesoflimit gauges for both holeand shaft.

9. Computer Integrated Manufacturing (CIM): Basic concepts of CIM, Evolution of CIM,Unmanned manufacturing , Elements of CIM, CIM implementation , CIM hardware and CIMsoftware.ProductdevelopmentthroughCIM,Sequentialengineering,Concurrentengineering,Comparisonofsequentialandconcurrentengineering,implementationofconcurrentengineering,concurrentengineeringandinformationtechnology,Characteristicsofconcurrentengineering. Soft computing in CIM: Artificial neural networks/Artificial intelligence, Fuzzy,Fuzzy AHP Benefits of CIM , Lean manufacturing , comparison of lean manufacturing withconventionalmanufacturing, applications ofleanmanufacturing,etc.

RecommendedBooks:

1. **DesigningforManufacturing -**HarryPeck,Pitman Publications, 1983.
2. **MachineDesign-**DieterMcGrawhill Publicationsfortopic1.

3. **Metrology-**R.K.JainKhannaPublicationfortopic6.
4. **Productdesignformanufactureandassembly-**GeoffreyBoothroyd,peterdewhurst,WinstonKnight, Merceldekker.Inc. Newyork.
5. **MaterialselectionandDesign,Vol.20-**ASMHandbook.

CAD5084:InstrumentationandControlSystems

Introduction

Classification and representation of control systems Examples of control systems, closed loopandopen loop control systems, TheLaplacetransform

MathematicalModellingofDynamicsystems

Transferfunctionandimpulseresponsefunction,blockdiagrams,signalflowgraph,state-spacerepresentation,Transientresponseanalysisoffirstorderandsecondordersystems

Timedomain analysisanddesign

Rootlocusmethod,Routhstabilitycriteria,effectofpolesandzerosonsystemperformance.

Frequencydomainanalysisanddesign

Bodeplot,Nyquist stabilitycriteria,Lag,leadcompensation

ModernControlTheory

Moderncontroltheory.Sequencecontrolandprogrammablelogiccontrollers.Controlcomponents.Comparators,hydraulic,pneumaticandelectricaltype

ofcontrollers,servomotors.
Electromechanical and electro-optical transducers and control elements. Signal conditioning,indicatingandrecordingelements.

Computerbasedsystems

Computerbaseddataacquisitionsystems,ADC,DAC.Microprocessorapplicationsinmeasurementand control. Static and dynamicanalysis.FFT analysers.

Analysisanddesign

Controllability and observability, pole placement method, examples of control system designusing MATLAB, Current developments in measurement and control of motion, force, torque,pressure,temperature, flow, noiseetc. Virtual instrumentation.

RecommendedBooks:

1. **ModernControlEngineering**,"K.Ogata"PHI.
2. **AutomaticControl Systems**,B.C.Kuo,PHI.
3. **ControlSystemEngineering**,Nise, Wiley.
4. **ModernControlSystems**,DorfandBishop,PearsonEducation.
5. **ModernControl SystemTheory,** M.Gopal,NewAgeInternational

CAD 5085:MechatronicsSystemDesign

Introduction: Definition and Introduction to Mechatronic Systems. Modeling & Simulationof Physical systems. Overview of Mechatronic Products and their functioning measurementsystems.Control Systems, simpleControllers.

StudyofSensorsandTransducers: PneumaticandHydraulicSystems,MechanicalActuationSystem,ElectricalActualSystems,RealtimeinterfacingandHardwarecomponentsforMechatronics.Interfacing,ADC,DAC,softwareandhardwareprinciplesandtoolstobuildmechatronicsystems.

Electrical Actuation Systems: Electrical systems, Mechanical switches, Solid state switches,solenoids,DC&ACmotors,Steppermotors.Designandselectionofmechatronicelements

namely sensors like encoders and resolvers. Stepper and servomotors. Ball screws, solenoidlikeactuators, andcontrollers

SystemModels: Mathematicalmodels:-

mechanicalsystembuildingblocks,electricalsystembuildingblocks,thermalsystembuildingblocks,electromechanicalsystems,hydro-mechanicalsystems, pneumatic systems.

Signal Conditioning: Signal conditioning, the operational amplifier, Protection, Filtering,Wheatstone Bridge, Digital signals , Multiplexers, Data Acquisition, Introduction to digitalsystemprocessing, pulse-modulation.

MEMSandMicrosystems: Introduction,WorkingPrinciple,MaterialsforMEMSandMicrosystems, Micro System fabrication process, Overview of Micro Manufacturing, MicrosystemDesign,and Micro system Packaging.

Data Presentation Systems: Basic System Models, System Models, Dynamic Responses ofSystem.

AdvancedApplicationsinMechatronics: FaultFinding,Design,ArrangementsandPracticalCase Studies, Design for manufacturing, User-friendly design. . Analysis and synthesis ofmechatronicsystemswithapplicationstoCNCsystems,robotics,consumerelectronicproductsetc.

RecommendedBooks:

1. **"Mechatronics"**-W. Bolton,2 Ed.Addison WesleyLongman, Pub,1999
2. **HSU**"MEMSandMicrosystemsdesign andmanufacture"**-TMH**
1. Kamm,"**UnderstandingElectro-MechanicalEngineeringan**
2. IntroductiontoMechatronics"-**PHI.**
3. **"FineMechanicsandPrecisionInstruments"**-PergamonPress, .1971.
4. Shettyand Kolk"**Mechatronics SystemDesign**"-Thomson.
5. Mahalik"**Mechatronics**"-TMH.
6. **"Mechatronics"–**HMT,TMH.

SEMESTER III

CAD 601 Advanced Vibrations and Control

Introduction

Introductiontounwantedmechanicalvibrationsandtheirharmfuleffectsincludingthoseonhumanbeings

Two-degreeof FreedomSystem

Principal modes of vibration, Spring coupled and mass coupled systems, Forced vibration ofan undamped close coupled and far coupled systems, Undamped vibration absorbers, Forceddampedvibrations, Vibration isolation.

Multi-degreeFreedomsystems

Eigen-value problem, Close coupled and far coupled systems, Orthogonality of mode shapes,Modal analysis for free, damped and forced vibration systems, Approximate methods forfundamentalfrequency-Rayleigh's,Dunkerely,StodolaandHolzermethod,Methodofmatrixiteration,Finite elementmethodfor close coupledand farcoupledsystems.

VibrationControl**:**

Vibration control strategies and case studies, experimental and theoretical routes to vibrationengineering,vibrationtesting.Lumpedparameteranddistributedparameter modeling ofmechanicalvibratorysystems,Vibrationcontrolsolutions,balancingofrotatingandreciprocatingmachines,Designofvibrationisolators,Auxilliaryma

sssystemsincludingtuneddampers for vibration control, Application of damping treatment for vibration control inmachinesand structures.

DynamicInstabilityControl:

Dynamic instability control,Introduction to modal tesing, modal updating and structuraldynamic modifications to improve dynamic design of machine structures, Active control ofvibrations,IntroductiontoNVHanditscontrol.Randomvibrations,Measurementandprocessingofrandom data.

Continuoussystems:

Forced vibration of systems governed by wave equation, Free and forced vibrations of beams/bars

Non-linearVibrations:

Non-linearsystems,Undampedandforcedvibrationwithnon-linearspringforces,Selfexcitedvibrations.

Lab contentsRecommendedBooks

1. TheoryandpracticeofMechanicalVibrations -J.S.RaoandK.Gupta-New AgeInternational
2. MechanicalVibrations-G.K.Groover -NemChand&Brothers
3. MechanicalVibrationPractice-V.Ramamurti-NarosaPublications
4. MechanicalVibrations-V.P. Singh-Dhanpat Rai&sons
5. TextbookofMechanicalVibrations-R.V.Dukkipati&J.Srinivas-PrenticeHallofIndia
6. Dynamicsofstructures-Chopra,Pearsonpress
7. VibrationandControl,A.K.Mallik

CAD 6021:MACHINEVISIONand ARTIFICIALINTELLIGENCE

CourseLearningObjectives

1 To gain and understanding of the fundamental issues and techniques for extractinginformationfromdigital images.
2 To have knowledge of well-established methods for processing, segmentation,featureextractionandrecognitionofobjects.
3 Toprovidethestudentwithprogramingexperiencefromimplementingcomputer visionandobjectrecognitionapplications

CourseContent

1. **Introduction**
   Machine Vision, difference between computer vision and machine vision.ralationship ofmachine vision to other fields, Applications of machine vision, typical machine visiontasks,components of digital image processing system, Digital images. Types of images, Elements ofmachine vision

system, Basic relationship between pixels (neighbors of apixel,connectivity,path,foreground,background,connectedcomponent,boundary,interior)labelingof connectedcomponents,Distancemeasure

2. **ImageProcessing**
   Digitization, Noise, Level of operations, Look up table. Image enhancement techniques bypoint processing(Negative of image, Contraststretching, HistogramEqualization, Histogramspecification),Image enhancement based on the neighborhood of pixels (spatial domain andfrequency domain) spatial domain techniques (Low pass filters and high pass filters, Highboostfilters),Imageenhancementinfrequencydomain(LowpassandHighpassfilters)

3. **ImageAnalysis**
   Segmentation of images (region based, Edge detection),Region based-thresholding, Types ofthresholds, Iterative threshold selection, Adaptive thresholding,Refion growing by pixelaggregation, Split and merge algorithm, Edge detection-point detection, line detection, edgedetection(Roberts,prewitt,Sobel,Laplacianoperations)

4. **Description**
   Shape representation, Topological shape descriptors, Contour-based Shape RepresentationTechniques-Simple Shape Descriptors,Signatures,Fourier descriptors, Boundary moments,Polygon approximation, Chain code, Region based shape representation techniques-simpleshape descriptors, Moment based features, Convex Hull, Skeleton of a region. Medical axistransform

5. **PatternRecognition**
   Pattern recognition methods-Structural methods, syntactic methods, Template matching,artificial neural network-biological neural network, usefulness and capabilities perceptron-singlelayer,multi-layer, backpropagationNeuralNetwork

6. **ArtificialIntelligence**
   Advanced search, Constraint satisfaction problems, Knowledge representation andreasoning, Non-standard logics, Uncertain and probabilistic reasoning (Bayesian networks,fuzzy sets).Foundations of semantic web: semantic networks and description logics. Rulessystems:useandefficient implementation.Planningsystems

CourseOutcomes:

1) Studentswillbe abletounderstandthe applicationofcomputervisioninindustrialtasks
2) Studentswill havetheknowledgeofvariousmethods ofenhancingImages
3) Students will be able to segment the images using spatial domain and frequencydomainmethods
4) Studentswillbeabletofindfeaturesinvarianttotranslation,rotation,scale
Studentswillbe abletorecognized/classifytheobjectsusingArtificialNeuralNetwork.

ReferenceBooks:

1) Digitalimage processingbyRfaelC.GonzalezandRichardE.Woods.
2) FundamentalsofDigitalimage processingbyAnilK. Jain
3) Digitalimageprocessing-Concepts,AlgorithmsandScientificApplicationsbyBerndJahne.
4) MachinevisionbyRameshJain,Rangachar Kasturi, BrainG.Schunck.
5) IntroductiontoNeuralNetworksusingMATLAB,S.N.Sivanandam.Sumuthi&S.N.Deepa.
6) ArtificialIntelligence: AModernApproach,StuartRussel,PeterNorvig
7) ArtificialIntelligence,2ndEdition, RichandKnight

CAD6022:DataAnalytics

Probability Theory: Sample Spaces- Events - Axioms – Counting - Conditional ProbabilityandBayes'Theorem–TheBinomialTheorem–Randomvariableanddistributions:MeanandVarianceof aRandomVariable-Binomial-Poisson-Exponential andNormaldistributions.

CurveFittingandPrinciplesofLeast Squares-Regressionandcorrelation.SamplingDistributions&DescriptiveStatistics:TheCentralLimitTheorem,distributionsofthesamplemean and the sample variance for a normal population, Sampling distributions (Chi-Square, t,F, z).

Test of Hypothesis- Testing for Attributes – Mean of Normal Population – One-tailed andtwo-tailedtests,F-testandChi-Squaretest,AnalysisofvarianceANOVA–Onewayandtwo-way classifications. Tabular data- Power and the computation of sample size- Advanced datahandling

Multipleregression-Linearmodels-Logisticregression-RatesandPoissonregression

Nonlinearcurvefitting.DensityEstimation-RecursivePartitioning-SmoothersandGeneralisedAdditiveModels-SurvivalsAnalysis-AnalysingLongitudinalData-SimultaneousInferenceand Multiple Comparisons- Meta-Analysis- Principal ComponentAnalysis-Multidimensional ScalingCluster Analysis.

Introduction to R- Packages- Scientific Calculator- Inspecting Variables- Vectors Matricesand Arrays- Lists and Data Frames- Functions- Strings and Factors- Flow Control and Loops-AdvancedLooping-Dateand Times.

Introduction to Python Packages- Fundamentals of Python- Inserting and Exporting Data-Data CleansingChecking and FillingMissingData-MergingData-Operations-Joins.

Books:

1. RichardCotton,"LearningR",O'Reilly,2013.
2. Dalgaard,Peter,"IntroductoryStatisticswithR",SpringerScience&BusinessMedia,2008.
3. BrainS.Everitt,"AHandbookofStatisticalAnalysisUsingR",SecondEdition,LLC,2014.
4. SamirMadhavan,"MasteringPythonforDataScience",Packt,2015.
5. SheldonM. Ross,Introduction to Probabilityand Statistics for Engineers and Scientists,4th edition,AcademicPress;2009.
6. Paul Teetor, "R Cookbook, O'Reilly, 2011. 7. Mark Lutz," Learning Python", O'Reilly,5thEdition,2013

CAD6023:PressureVesselsand Piping Design

Stressesinpressurevessels

Membrane stresses, dilation of pressure vessels, thick cylinder and thick sphere, bending ofplate,discontinuitystresses in pressurevessels, thermal stresses.

Factorsinfluencingthedesign ofpressurevessels

Designcriterionofelliptical,hemispherical,conical,toriconicalandtorisphericalheads,Autofrettage.

Designofpressurevesselcomponentssuchasshells,heads,nozzles,flangesasperASMEandIS codes

Localised stresses, stress concentration about a circular and an elliptical opening, theory ofreinforcedopenings, nozzle reinforcement, welded joints.

FractureControl

Fatigue of various components of pressure vessels, Fatigue life prediction, thermal stressfatigue,criteriafordesign with defects.

Piping elements, Dynamic analysis of pipingUse of FEM softwares for stress calculations

RecommendedBooks:

1. **Pressurevessel design**-Harvey

CAD 6024 :Noise andAcoustic Design

MathematicalBasisofAcoustics

Acousticswaves–Linearwaveequation–soundinfluids–Harmonicplanewaves–Energydensity–Acousticsintensity–Specificacousticimpedance–sphericalwaves–Describerscales.ReflectionandTransmission: Transmission from one fluid to another normal and oblique incidence – method ofimages.

RadiationandReceptionofAcousticsWaves

Radiationfromapulsatingsphere–Acousticreciprocity–continuouslinesource–radiationimpedance
-Fundamentalpropertiesoftransducers.AbsorptionandattenuationofsoundAbsorptionfromviscosity– complex soundspeedand absorption–classical absorption coefficient

Pipes ResonatorsandFilters

Resonanceinpipes-standingwavepatternabsorptionofsoundinpipes–longwavelengthlimit–Helmoltzresonator-acousticimpedance-reflectionandtransmissionofwavesinpipe–acousticfilters
–lowpass, high passand band pass.

Noise,Signal detection,Hearingandspeech

Noise, spectrum level and band level – combing band levels and tones – detecting signals in noise –detection threshold – the ear – fundamental properties of hearing – loudness level and loudness – pitchand frequency– voice.

ArchitecturalAcoustics

Sound in enclosure – A simple model for the growth of sound in a room – reverberation time - Sabine,sound absorption materials – measurement of the acoustic output of sound sources in live rooms –acousticsfactorin architecturaldesign.

EnvironmentalAcoustics:

Weighted sound levels speech interference – highway noise – noise induced hearing loss – noise andarchitectural design specificationand measurement ofsome isolationdesign ofportions.

MeasurementofSoundandVibration

Measurement microphones: construction, sensitivity, linearity, frequency response, polar response,dynamicrange.Relevantstandardsforsoundlevelmeters,Calibrationandcalibrators.Measurementofsoundpressure level, soundpowerlevel, soundintensitylevel, vibrationtransducers.

NoisePollution

Sources of noise and its intensity, effects of noise pollution, Prevention and control measures of noisepollution.

RecommendedBooks:

1. LawerenceE.Kinsler,Austin,R.Frey,AlanB.Coppens,JamesV.Sanders,**FundamentalsofAcoustics**,4htedition, Wiley, 2000.
2. L.Berarek,**"Acoustics"**-McGraw-Hill

CAD 6025 :DynamicBehaviourofMaterials

ElasticWavepropagation

Introduction: dynamic deformation and failure, Introduction to waves: elastic waves; types ofelasticwaves; reflection, refraction andinteractionof waves.

Inelasticwavepropagation

Plasticwavesandshockwaves:Plasticwavesofuniaxialstress,uniaxialstrainandcombinedstress; Taylor's experiments;shock waves,Shock wave induced phase transformation;Explosive-materialinteraction and detonation.

ExperimentalTechniques

Experimental techniques for dynamic deformation: intermediate strain rate tests; splitHopkinson pressure bar; expanding ring test; gun systems, Review of mechanical behavior ofmaterials (especially metals): Elastic and plastic deformation of metals; dislocationmechanics.

Plasticdeformationofmetalsathighstrain rates

Empirical constitutive equations; relationship between dislocation velocity and applied stress;physically based constitutive equations, Plastic deformation in shock waves: Strengtheningdue to shock wave propagation; dislocation generation; point defect generation anddeformation

twinning, Strain localization/shear bands: Constitutive models; metallurgicalaspects.

Dynamicfracture mechanics

Fundamentalsoffracturemechanics;limitingcrackspeed,crackbranchinganddynamicfracturetoughness; spallingandfragmentation.

Dynamicdeformationof non-metals

Dynamic deformation of materials other than metals: Polymers; ceramics; composites,Applications:Armor applications; explosiveweldingandforming.

RecommendedBooks :

1. MarcA. Meyers, DynamicBehavior ofMaterials, JohnWiley&Sons,NewYork, 1994
2. L.B.Freund,DynamicFractureMechanics,Cambridge,1990
3. Y.BaiB.Dodd,AdiabaticShear Localization,Pergamon,Oxford,UK,1992
4. G.E.Dieter,MechanicalMetallurgy,McGrawHill,1986
5. J.W.Swegle,D.E. Grady,inShock WavesinCondensed Matter-1985,