Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

(Only for the Courses relating to Research Domains for both Full Time & Sponsored Part Time)

Department: Civil Engineering

1) Research/Specialization Group: 1

(Name of the Group): Structural Engineering

Course Code & Course Name:

Sl No	Name of the Scholar	Course Code for Comprehensive exam
1	AAKASH KUMAR	CE 504 and CE 555
2	SAHIL PRITAM SWAIN	CE 559 and CE 502
3	TEIBORLANG WARJRI	CE 559 and CE 502

Syllabus Content:

1. **CE 504 (Finite Element Method)**:
   a. Element Properties: Natural Coordinates; Triangular Elements; Rectangular Elements; Lagrange and Serendipity Elements; Isoparametric Formulation; Stiffness Matrix of Isoparametric Elements; Numerical Integration: One Dimensional; Numerical Integration: Two and Three Dimensional.
   b. Analysis of Frame Structures: Stiffness of Truss Members; Analysis of Truss; Stiffness of Beam Members; Finite Element Analysis of Continuous Beam; Plane Frame Analysis.

2. **CE 555 (Dynamic of Structures)**
   a. Dynamics of Single Degree-of-Freedom Structures: Dynamic equation of equilibrium; Free vibration of single degree of freedom systems; Forced vibration: harmonic and periodic loadings; Dynamic response functions, force transmission and vibration isolation; SDOF response to arbitrary functions.
   b. Earthquake Response of SDOF Systems: Earthquake excitation, response history and construction of response spectra; Response spectrum characteristics and design spectrum.

3. **CE 559 (Advance Concrete Technology)**
   a. Strength and durability of concrete: Factors affecting the strength, curing of concrete, strength in tension, failure in compression, aggregate cement paste interface, effect of age on strength of concrete, relationship between compressive and tensile strength, bond strength. Causes of inadequate durability, transportation mechanism in concrete, diffusion, absorption, water permeability of concrete, air and vapour permeability, carbonation, acid attack on concrete, sulphate attack on concrete, chloride attack, and test for penetrability of concrete to chloride.
   b. Microstructure analysis techniques: Working principle of Scanning Electron Microscope (SEM), Energy Dispersive X-ray Spectrometry (EDS), X-ray Powder Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR) analysis techniques, TGA (Thermo Gravimetric analysis) and DTA (Differential Thermal Analysis).

Signatures and Names of DRC Members:

1. Dr. C Marthong
2. Dr. S Sahoo
3. Dr. S Sharma
4. Dr. P K Gautam
5. Dr. H M Kalita
6. Dr. M L Patton
7. Dr. D K Sarma

Signature of DRC Chairman
Date: 01.02.2023

Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

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Department: Civil Engineering

4. **CE 502 (Advance Structural Design)**
   a. Basic load calculation and design concept: Dead load, live load, wind and seismic load calculation for different types of structures according to IS code. Basic design philosophy of RCC structures (working stress and limit state method of design).
   b. Ductile Detailing Concept of Ductility: Detailing for ductility – Design of beams, columns for ductility - Design of cast-in-situ joints in frames.

2) Research/Specialization Group: 2

(Name of the Group): Geotechnical Engineering

Course Code & Course Name:

Sl No	Name of the Scholar	Course Code for Comprehensive exam
1	BADAVATH NAVEEN	CE 564 & CE 506

Syllabus Content

1. **CE 564 (Advance Foundation Design):**
   a. Bearing capacity theories (Terzaghi's, Meyerhoff's, Hansen's, Vesic's, Balla's)- foundations subjected to centric vertical loads, inclined loads, eccentric loads, foundations on layered soils, anisotropic soils, foundations on slopes. Estimation load carrying capacity of single and pile group under various loading conditions. Pile load testing (static, dynamic methods and data interpretation), settlement of pile foundation, code provisions, design of single pile and pile groups, and pile caps. Load transfer mechanism, Pile capacity in various soil types, negative skin friction, group action, settlements.

2. **CE 506 (Slopes and Retaining structures):**
   a. Slope stability: infinite slopes; finite height slopes – Swedish method, Bishop's simplified method and other limit equilibrium methods; Stability charts; conditions of analysis – steady state, end of construction and sudden draw down; earthquake effects. Seepage: flownet in isotropic, anisotropic and layered media; entrance-exit conditions; determination of phreatic line. Road and rail embankments. Reinforced slopes. Soil nailing; Gabions. Earth Pressure: Types; Rankine's theory and Coulomb's theory; Effects due to wall friction; Graphical methods; Earthquake effects.) Rigid retaining structures: Types; stability analysis. Flexible retaining structures: Types; material; cantilever sheet piles; anchored bulkheads–methods of analysis, moment reduction factors; anchorage. Reinforced soil walls: Elements and stability.

Signatures and Names of DRC Members:

1. Dr. C Marthong
2. Dr. S Sahoo
3. Dr. S Sharma
4. Dr. P K Gautam
5. Dr. H M Kalita
6. Dr. M L Patton
7. Dr. D K Sarma

Signature of DRC Chairman
Date: 01.02.2023

Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

(Only for the Courses relating to Research Domains for both Full Time & Sponsored Part Time)

Department: Civil Engineering

3) Research/Specialization Group: 3

(Name of the Group): Environmental Engineering

Course Code & Course Name:

Sl No	Name of the Scholar	Course Code for Comprehensive exam
1	AISHI NATH	CE 514, CE 515 and CE 580

Syllabus Content

1. **CE 514 (Air and Noise Pollution):**
   a. Sources and classification of air pollutants, Atmospheric meteorology, Global air pollution, Legislations and regulations: Ambient air quality standards, Emission standards, emission inventory, wind profiles, topographic effects, temperature profiles in atmosphere, stability, inversions, plume behaviour, turbulent diffusion, concept of mixing height. Air sampling design, analysis and interpretation of air pollution data, guidelines of network design in urban and rural areas. Stack monitoring, Dispersion of air pollutants and modelling – Types and classification of models, purpose of air quality modelling, Box models, Gaussian dispersion model – Assumptions, modifications for ground reflection, line sources and complex terrain. Physics of plume rise, Holland's equation, Briggs equation, etc. Indoor air quality modelling. Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; noise criteria, effects of noise on health, annoyance rating schemes.

2. **CE 515 (Physico-Chemical Processes in Environmental Engineering):**
   a. Physical, Chemical and Biological quality Parameters of surface and sub-surface waters and wastewater, Potable Water Standards, Wastewater Effluent Standards, Unit Processes, theory and design of physicochemical unit operations, screening, grit chamber, equalization, sedimentation, floatation, coagulation, flocculation, filtration, disinfection, water softening, adsorption, ion exchange, aeration and gas transfer, Unit operation & Design water treatment Plant.

3. **CE 580 (Environmental Management):**
   a. Environmental impact assessment (EIA), environmental impact factors and areas of consideration, measurement of environmental impact, scope and methodologies of EIA, status of EIA in India. Environmental audit versus accounts audit.

Signatures and Names of DRC Members:

1. Dr. C Marthong
2. Dr. S Sahoo
3. Dr. S Sharma
4. Dr. P K Gautam
5. Dr. H M Kalita
6. Dr. M L Patton
7. Dr. D K Sarma

Signature of DRC Chairman
Date: 01.02.2023

Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

(Only for the Courses relating to Research Domains for Full Time & Sponsored Part Time)

Date of Comprehensive Exam: 22nd Feb, 2023

Department: Computer Science and Engineering

1) Research/Specialization Group: 1

(Name of the Group): Computer Network & Security

Syllabus Content { should be an extract from the course syllabus (not the entire syllabus) which will be helpful for the research work of the scholar }:

(a) Course Code and Course Name : *CS 305: Selected Topics in Computer Network syllabus:*
Medium Access Control: ALOHA, CSMA, CSMA/CD, token ring, token bus, Network Layer Addressing IP version 4 and 6, Intra- and Inter-domain Routing, Distance Vector Routing, Link State Routing Path Vector Routing, Multicast Routing Protocol.
Wireless communication, Fading, Hands off, Wireless multiple access protocols, Ad-Hoc network, MAC protocols, Network Layer Protocols, TCP over wireless applications, Mobile IP.

(b) Course Code and Course Name : *CS 416: Selected Topics in Wireless Sensor Network:*
Wireless Sensor Network, Coverage, Connectivity, longevity, scheduling, synchronizations in WSNs, WSN Hardware, Internet of Things, WSN Deployment, Routing Protocols for WSNs, Fault Tolerance, Network Protocols, Data Storage.

(b) Course Code and Course Name: *CS 322: Selected Topics in Network Security Syllabus:*
Security Architectures and Protocols, Distributed Denial-of-Service (DDoS) attacks and defence, Worm defence, Botnets defence, Security of IEEE 802.11 WLANs, Mobile malware detection and defence, Social network security and privacy, Security of mobile ad hoc networks, Security of wireless sensor networks, Security of vehicular networks, Security in cloud computing.

(c) Course Code and Course Name: *CS 517 : Soft Computing Syllabus:*
Fuzzy Sets and Membership Function, Fuzzy If-Then Rules, Fuzzy Models, Fuzzy Logic Controller, Neural Networks- Backpropagation, Extended Backpropagation for Recurrent Networks, Genetic Algorithm, Particle Swarm Optimization, Ant Colony Optimization.

(d) Course Code and Course Name: *CS 521 : Number Theory and Cryptography Syllabus:*
Mathematics of symmetric key and non-symmetric key cryptography, Encryption algorithms- DES, AES, hash functions-MD5, SHA, Signatures- RSA, ring signature, group signature, blind signature, aggregate signature, Elliptic curve Crytography.

(e) Course Code and Course Name: *CS 701 :Advanced Data Structures and Algorithms Syllabus:*
Array, Linked List, Stack, Queue, Double-Ended Queue, Search Trees, Height-Balanced Trees (or AVL Trees), Weight-Balanced Trees, Red-Black Trees, Splay Trees, Skip List, Balanced Search Trees as Heaps, Hash Tables and Collision Resolution, Hash Functions, Hash Trees, Selection Sort, Bubble Sort, Mergesort, Quicksort, Heapsort, Bucket and Radix Sort, Basic Algorithm Paradigms – Divide and Conquer, Greedy Algorithms, Dynamic Programming with examples, Minimum Spanning Trees.

(f) **Course Code and Course Name** : *CS 519 : Cloud Computing Syllabus:*

Virtualization: Basic concept– Hypervisor- Types of virtualization- hardware, operating system, server, storage- Features of virtualization- Advantages and disadvantages of different types of virtualization. Cloud Architecture:Types of deployment models-Private, Public , Hybrid, Community, Types of service models-Iaas, PaaS, SaaS.

2) Research/Specialization Group: 2

(Name of the Group): Computer Vision and Computational Intelligence

Syllabus Content { should be an extract from the course syllabus (not the entire syllabus) which will be helpful for the research work of the scholar }

(a) **Course Code and Course Name:** *CS 511 : Image Processing Syllabus:*

Basics of Image processing:Visual Perception, Image Sampling and Quantization, Basic relationships between Pixels, Image File Format, Histogram Processing, Enhancement using Arithmetic/ Logic Operations, Smoothing and Sharpening Spatial Filters, Restoration in the presence of Noise only - Spatial Filtering, Inverse Filtering, Weiner Filtering.

Feature Selection and Feature Extraction - Probabilistic Separability based criterion functions, Interclass Distance based criterion functions, Branch and Bound algorithm, Sequential Forward/ Backward selection algorithms, (l, r) algorithm, Feature Extraction based on PCA, LDA.

Clustering - Different Distance functions and Similarity Measures, Criterion for Clustering, Minimum Within Cluster Distance criterion, Methods of Clustering - Partitional, Hierarchical, Graph theoretic, Density based, Clustering Validity.

(b) **Course Code and Course Name:** *CS 513 : Artificial Intelligence Syllabus:*

Basics of Artificial Intelligence: State Space Search, Uninformed Search - Breadth First Search, Depth First Search, Stochastic Search - Hill Climbing, Simulated Annealing, A*, AO*, Constraint Satisfaction Problems, First Order Predicate Logic, Planning - Goal Stack Planning, Overview of different forms of Learning: Unsupervised, Supervised, Semi-supervised

Pattern recognition basics: Classification - Bayesian Decision Rule, Minimum Distance Classifier, Mahalanobis distance, Maximum Likelihood Classification, kNN Classifier, Decision Tree, Artificial Neural Networks: Introduction to Expert Systems and Robotics

Expert systems - Architecture, Knowledge Representation, Basic forms of Inference - Abduction, Deduction, Induction, Knowledge Engineering, Robotics - Classification with respect to Geometrical Configuration (Anatomy), Sensors.

(c) **Course Code and Course Name** : *CS 519 : Cloud Computing Syllabus:*

Virtualization: Basic concept– Hypervisor- Types of virtualization- hardware, operating system, server, storage- Features of virtualization- Advantages and disadvantages of different types of virtualization. Cloud Architecture: Types of deployment models-Private, Public , Hybrid, Community, Types of service models-Iaas, PaaS, SaaS.

(d) **Course Code and Course Name:** *CS 701 :Advanced Data Structures and Algorithms Syllabus:*

Array, Linked List, Stack, Queue, Double-Ended Queue, Search Trees, Height-Balanced Trees (or AVL Trees), Weight-Balanced Trees, Red-Black Trees, Splay Trees, Skip List, Balanced Search

Trees as Heaps, Hash Tables and Collision Resolution, Hash Functions, Hash Trees, Selection Sort, Bubble Sort, Mergesort, Quicksort, Heapsort, Bucket and Radix Sort, Basic Algorithm Paradigms – Divide and Conquer, Greedy Algorithms, Dynamic Programming with examples, Minimum Spanning Trees.

3) Research/Specialization Group: 3

(Name of the Group): High Performance Computing

Syllabus Content { should be an extract from the course syllabus (not the entire syllabus) which will be helpful for the research work of the scholar }

(a) Course Code and Course Name : *CS 202: Computer Organization:*
Performance: Definition, Nuances and Metrics for measuring performance; MIPS, CPI, Benchmarking, Amdahl's Law
Performance oriented design of ALU, Control Unit, Memory and I/O units

(b) Course Code and Course Name : *CS 304 : Operating Systems:*
Performance oriented Aspects of Operating System Design: CPU Scheduling, Memory management (paging, segmentation, demand paging, fragmentation/ compaction etc., memory allocation algorithms)

(c) Course Code and Course Name : *CS 413: High Performance Architectures*:
Parallelism on Uni-processor: Basic parallel processing techniques: instruction level, thread level and process level. Basic concepts of pipelining, Arithmetic pipelines, Instruction pipelines, Hazards in a pipeline: structural, data and control hazards, Overview of hazard resolution techniques, Dynamic instruction scheduling, Brach prediction techniques, Instruction-level parallelism using software approaches, Superscalar techniques, Speculative execution.
Parallelism in uniprocessor System, memory-interleaving, pipelining and vector processing.
Multi-Processors: Centralized vs. distributed shared memory, Interconnection topologies, Multiprocessor architecture, Symmetric multiprocessors, Cache coherence problem, memory consistency, Multicore architecture, Case study: multiprocessors, co-processors like GPU.

(d) Course Code and Course Name : *CS 705: Parallel Processing: Architectures And Algorithms:*
Process Level Parallelism: Distributed Computers, Clusters, Grid. Middlewares for realizing distributed computing platforms. Virtualization: Characteristics & Taxonomy,

Parallel computer structures, architectural classifications, parallel computer models: PRAM and VLSI complexity models, program properties: conditions of parallelism, program partitioning and scheduling, granularity and scalability.

Systems interconnect architectures: Static interconnection networks array, tree, mesh, pyramid, hypercube, cubeconnected-cycles, butterfly; Dynamic interconnection networks crossbar, multistage interconnection networks, blocking, non-blocking and rearrangeable operations, properties and routing. Networked computers as a multi-computer platform, basics of message-passing, computing using workstation clusters, Software tools.

Parallel algorithms and their mapping on different architectures for: Arithmetic computations, Matrix operations, Numerical applications, Sorting, Graph algorithms, Computational Geometry applications among others.

Cloud Computing: High performance Vs. High Throughput computing, Data Intensive Computing in the Cloud, Hadoop, Map Reduce programming paradigm.

(e) **Course Code and Course Name:** *CS 701 :Advanced Data Structures and Algorithms:*
Array, Linked List, Stack, Queue, Double-Ended Queue, Search Trees, Height-Balanced Trees (or AVL Trees), Weight-Balanced Trees, Red-Black Trees, Splay Trees, Skip List, Balanced Search Trees as Heaps, Hash Tables and Collision Resolution, Hash Functions, Hash Trees, Selection Sort, Bubble Sort, Mergesort, Quicksort, Heapsort, Bucket and Radix Sort, Basic Algorithm Paradigms – Divide and Conquer, Greedy Algorithms, Dynamic Programming with examples, Minimum Spanning Trees.

4) Research/Specialization Group: 4

(Name of the Group): Data Science and Machine Learning

Syllabus Content { should be an extract from the course syllabus (not the entire syllabus) which will be helpful for the research work of the scholar }

(a) **Course Code and Course Name** : *CS 510: Data Mining Syllabus:*
Data–Preprocessing: Data Quality Issues, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization
Mining Frequent Pattern Mining and Association Rules: Basic Concepts, Apriori Algorithm, Frequent Pattern growth (FP-growth) Algorithm, Mining Closed and Max Patterns, Pattern Evaluation Methods, Constraint-Based Frequent Pattern Mining
Classification Techniques: Basic Concepts, Decision Tree Classifier, Rule-Based Classifier, Nearest Neighbor Classifiers, Model Over fitting, Model Evaluation and Selection
Clustering Techniques: Overview, Types of Clustering Methods, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Performance Parameters, Clustering with Constraints
Outlier Detection: Basic Concepts, Outlier Detection Methods, Statistical Approaches, Proximity-Based Approaches, Clustering-Based Approaches, Classification-Based Approaches.

(b) **Course Code and Course Name:** *CS 516 : Pattern Recognition Syllabus:*
Linear Algebra, vector spaces, probability theory, estimation techniques.
Bayesian decision rule, Error probability, Minimum distance classifier, Mahalanobis distance, Discriminant functions and decision boundaries; Maximum likelihood classification, K-NN Classifier, Linear and nonlinear Classifier, Branch and bound algorithm, Feature selection and feature extraction, PCA algorithm. Parameter estimation, Density estimation.

(c) **Course Code and Course Name:** *CS 708 : Computational Geometry Syllabus:*
Quick hull, Plane-sweep algorithm, Triangulating monotone polygons, Guarding art gallery – problem, 1-D range searching, Farthest point Voronoi diagram, Fortune's plane sweep algorithm, Line arrangements, Visibility graphs, Motion planning and shortest paths for a point robot

(d) Course Code and Course Name: *CS 517 : Soft Computing Syllabus:*

Fuzzy Sets and Membership Function, Fuzzy If-Then Rules, Fuzzy Models, Fuzzy Logic Controller, Neural Networks- Backpropagation, Extended Backpropagation for Recurrent Networks, Genetic Algorithm, Particle Swarm Optimization, Ant Colony Optimization.

(e) Course Code and Course Name: *CS 701 :Advanced Data Structures and Algorithms Syllabus:*

Array, Linked List, Stack, Queue, Double-Ended Queue, Search Trees, Height-Balanced Trees (or AVL Trees), Weight-Balanced Trees, Red-Black Trees, Splay Trees, Skip List, Balanced Search Trees as Heaps, Hash Tables and Collision Resolution, Hash Functions, Hash Trees, Selection Sort, Bubble Sort, Mergesort, Quicksort, Heapsort, Bucket and Radix Sort, Basic Algorithm Paradigms – Divide and Conquer, Greedy Algorithms, Dynamic Programming with examples, Minimum Spanning Trees.

Signatures and Names of DRC Members:

1. S. Moulik (Soumen Moulik)
2. (D. Kumar)
3. (D S Roy).
4. (G Pandey)
5. (B. K. Balabantaray)
6. _____
7. _____
8. _____

01/02/2023

Signature of DRC Chairman

Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

Department: Mechanical Engineering

1) Research/Specialization Group: 1

(Name of the Group): Thermal and Fluids Engineering

Syllabi for: P22ME002 and P22ME005

Advanced Fluid Mechanics [30 Marks]

Basic concepts of Fluid Mechanics
Basic concept and Governing Equations of Fluid Motion: Definition and Properties of Fluids, Langragian and Eulerian description, Velocity and stress field, Fluid statics, Fluid Kinematics, Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler's equation, Bernoulli's Equation

Laminar Boundary Layers
Boundary layer equations, Boundary layer parameters, Boundary layer on a flat plate, Integral form of boundary layer equations, Approximate Methods, Flow separation and control, Hagen Poiseuille Flow, Plane Poiseuille Flow, and Couette Flow

Potential Flows
Stream and Velocity Potential Function, Circulation, Irrotational Vortex, Source and Sink, Vortex Flow, Doublet, Flow Past a Circular Cylinder, Magnus Effect; Kutta-Joukowski Lift Theorem; Concept of Lift and Drag.

References:

1. F. P. Incropera & D.P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Willey & Sons
2. A. Bejan, "Convective Heat Transfer", John Wiley and Sons
3. K. Muralidhar and G. Biswas, "Advanced Engineering Fluid Mechanics", Narosa

Conduction and Radiation [40 Marks]

Governing Equations
Basic modes of heat transfer, Heat transfer mechanisms, Governing laws, Reynolds Transport Theorem (RTT), Derivation of Energy Equation, Fourier's Law

Conductive Heat Transfer systems
Heat conduction equations in isotropic and anisotropic materials, Initial and boundary conditions, 1-D conduction problems without and with heat generation, Plane wall, hollow cylinder, composite tube, hollow sphere, Steady 2-D heat conduction problem, Problems in cylindrical and spherical coordinate system, Bounded 1-D domain, Slab with heat generation, Principle of superposition, Thermal Resistance, Transient Response, Semi-infinite solid, Polar co-ordinate (2-D), Time dependent BCs

Radiative Heat Transfer
Mechanism of energy transport in thermal radiation Divergence of radiative heat flux, Laws of radiation, View factor and solid angle, Radiation in presence of participating medium, Radiation transport equations (RTE), Radiative equilibrium

References:

1. F. P. Incropera & D.P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Willey & Sons
2. A. Bejan, "Convective Heat Transfer", John Wiley and Sons
3. K. Muralidhar and G. Biswas, "Advanced Engineering Fluid Mechanics", Narosa

Measurement Systems in Mechanical Engineering [30 Marks]

Experimental Objectives
Monitoring, Control and Research, Systems and Variables Identifications for Mechanical Systems, Planning of Instrumentations

Measurement Systems
Generalized Description of the Measurement System, Operational Description of the General Measurement System and Elimination Method of Interfering Inputs to the Desired Inputs, Null and Deflection Methods of Measurements, Analog and Digital Measurements, Order of Instruments and Calibration, Performance Characteristics, Frequency Response

Analysis of Experimental Data
Causes and Types of Experimental Errors, Error Analysis on a Common-Sense Bias, Uncertainty Analysis and Propagation of Uncertainty, Evaluation of Uncertainties for Complicated Data Reduction, Statistical Analysis of Experimental Data, Probability Distributions, The Gaussian or Normal Error Distribution, Method of Least Squares, the Correlation Coefficient, Multivariable

Regression, Standard Deviation of the Mean, Graphical Analysis and Curve Fitting, Design of Experiments, Aliasing, Constructing Fractional Design, Taguchi's Design

Sensors and Transducers
Data Sampling, Signal Conditioning and Computer Data Acquisition. Error Response Characteristic of Sensors, Measurement Error

Measurement of Process Variables
Pressure Measurement: Dynamic Response, Dead Weight Pressure Tester, Bourdon Gauge; Low Pressure Measurement Techniques- the McLeod Gauge, Pirani Thermal Conductivity Gauge, Knudsen Gauge
Flow Measurement: Positive Displacement Methods, Flow Obstruction Methods, the Sonic Nozzle, Hot Wire and Hot Film Anemometer, Magnetic Flow Meter, Flow Visualization Method, LDA
Temperature Measurement: Temperature Scales, the Ideal Gas Thermometer, Temperature Measurement by Mechanical Effect, Electrical Effect, Radiation, Effect of Heat Transfer on Radiation, Transient Response of Thermal Systems, Thermocouples, and Temperature Measurement in High-Speed Flow

Measurement of Force, Torque and Power
Force Measurement: Platform Balance, Force to Displacement Conversion, Conversion of Force to Hydraulic Pressure, Piezoelectric Force Transducer
Measurement of torque and power: Torque Measurement: Electric Generator as a Dynamometer, Measurement of Rotational Speed

References

1. J. P. Holman, "Experimental methods for Engineers",McGraw-Hill.
2. R. S. Sirohi and H. C. Radha Krishna, "Mechanical Measurements", Wiley.

Syllabi for: P21ME002

Combustion and Emission in Diesel Engines [50 Marks]

Operating Parameters
Bore-Stroke, Dead Centres, Clearance and Swept Volumes, Capacity, Compression Ratio, Torque, Power, Mean Effective Pressure, Specific Fuel Consumption, Specific Energy Consumption, *Problems*.

Fuels
CI Engine Fuels & Their Rating, Alternating Fuels to be used in CI and Types, *Problems*.

Fuel Injection and Mixing
Injection Pumps, Types of Nozzles, Injection Timing, Mechanical and Pneumatic Governors, Spray Characteristics, Swirl, Squish and Tumble, Electronic Injection Systems, *Problems*.

Combustion in C.I. Engines
Stages, Injection Delay, Factors Influencing the Delay, Knocking, Effect of Variables on Knocking, *Problems*.

Emissions and Control
Primary and Secondary Air Pollutants, Other Emissions, EGR, Catalytic Converter, DPF, Emission Norms.

Measurement and Testing
Frictional Power, Indicated Power, Brake Power, Fuel Consumption, Air Consumption, Efficiencies, Pressure Smoothing Technique, Measurement and Calculation of Pressure Rise Rate and Net Heat Release Rate, Heat Balance, Performance Maps, Variables Affecting Performance, *Problems*.

References:

1. V. Ganesan, "Internal Combustion Engines", TMH
2. R. Stone, "Internal Combustion Engines", The Macmillan Press Limited
3. C.R. Fergusan and A.T. Kirkpatrick, "Internal Combustion Engines", John Wiley & Sons.
4. J.B. Heywood, "Internal Combustion Engine Fundamentals", McGraw Hill.
5. U.K. Saha, "IC Engines", Course Material under QIP CD Cell Project, IIT Guwahati.

Measurement Systems in Mechanical Engineering [50 Marks]

Analysis of Experimental Data
Measurements error and uncertainty analysis, design of experiments, order of Instruments and calibration, performance characteristics, frequency response.

Sensors and Transducers
Data sampling, Signal Conditioning and Computer data Acquisition. Error response characteristic of sensors, Measurement error.

Measurement of Process Variables

Pressure Measurement: Dynamic response, dead weight pressure tester, Bourdon gauge; low pressure measurement techniques-the McLeod gauge, Pirani thermal conductivity gauge, Knudsen gauge.

Flow Measurement: Positive displacement methods, flow obstruction methods, the sonic nozzle, hot wire and hot film anemometer, magnetic flow meter, flow visualization method, LDA.

Temperature Measurement: Temperature scales, the ideal gas thermometer, temperature measurement by mechanical effect, electrical effect, radiation, effect of heat transfer on radiation, transient response of thermal systems, thermocouples, temperature measurement in high-speed flow.

Measurement of Force, Torque and Power

Force Measurement: Platform balance, Force to displacement conversion, Conversion of force to hydraulic pressure, piezoelectric force transducer.

Measurement of torque and power: Torque Measurement: Electric generator as a dynamometer, Measurement of rotational speed,

References

1. J. P. Holman, "Experimental methods for Engineers", McGraw-Hill.
2. R. S. Sirohi and H. C. Radha Krishna, "Mechanical Measurements", Wiley.

Syllabi for: P22ME001

Advanced Fluid Mechanics [35 Marks]

Basic concepts of Fluid Mechanics

Basic concept and Governing Equations of Fluid Motion: Definition and Properties of Fluids, Langragian and Eulerian description, Velocity and stress field, Fluid statics, Fluid Kinematics, Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler's equation, Bernoulli's Equation

Laminar Boundary Layers

Boundary layer equations, Boundary layer parameters, Boundary layer on a flat plate, Integral form of boundary layer equations, Approximate Methods, Flow separation and control, Hagen Poiseuille Flow, Plane Poiseuille Flow, and Couette Flow

Potential Flows

Stream and Velocity Potential Function, Circulation, Irrotational Vortex, Source and Sink, Vortex Flow, Doublet, Flow Past a Circular Cylinder, Magnus Effect; Kutta-Joukowski Lift Theorem; Concept of Lift and Drag.

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1. F. P. Incropera & D.P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Willey & Sons
2. A. Bejan,"Convective Heat Transfer", John Wiley and Sons
3. K. Muralidhar and G. Biswas, "Advanced Engineering Fluid Mechanics", Narosa

Computational Fluid Dynamics [35 Marks]

Introduction and Conservation Principles

Fundamental conservation laws of fluid motion and heat transfer

Classification of Partial Differential Equations and Approximate Solutions

Mathematical classification of PDEs – parabolic, elliptic and hyperbolic equations, Role of characteristics in PDEs, Approximate solutions of differential equations, Primary and secondary variables, essential and natural boundary conditions

Fundamentals and Common Methods of Discretization

Principles of discretization – preprocessing, solution and post processing, Types of boundary conditions, Conservativeness, boundedness, transportiveness, Overview of finite difference and finite volume methods

Numerical Solutions

Numerical solution of parabolic partial differential equations using finite-difference and finite-volume methods: explicit and implicit schemes, consistency, stability and convergence, Numerical solution of systems of linear algebraic equations: Necessary and sufficient conditions for convergence of iterative schemes

Diffusion

The finite volume method of discretization for diffusion problems: Discretization of transient one-dimensional and multi-dimensional diffusion problems, Stability analysis, FTCS, FTFS, FTBS, schemes, Convection-diffusion problems: Central difference, upwind schemes, exponential, hybrid and power-law schemes, QUICK scheme, Concept of false diffusion

Numerical Solution of Navier-Stokes Equations

Staggered grid and collocated grid, SIMPLE, SIMPLER algorithms

References:
1. H. K. Versteeg and W. Malalasekera, "An introduction to computational fluid dynamics: The finite volume method", Pearson Education, 2008
2. J. D. Anderson Jr., "Computational Fluid Dynamics", McGraw-Hill International Edition, 2017
3. T. J. Chung, "Computational Fluid Dynamics", Cambridge University Press, 2010
4. S.V. Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere, 2018

Measurement Systems in Mechanical Engineering [30 Marks]

Experimental Objectives
Monitoring, Control and Research, Systems and Variables Identifications for Mechanical Systems, Planning of Instrumentations

Measurement Systems
Generalized Description of the Measurement System, Operational Description of the General Measurement System and Elimination Method of Interfering Inputs to the Desired Inputs, Null and Deflection Methods of Measurements, Analog and Digital Measurements, Order of Instruments and Calibration, Performance Characteristics, Frequency Response

Analysis of Experimental Data
Causes and Types of Experimental Errors, Error Analysis on a Common-Sense Bias, Uncertainty Analysis and Propagation of Uncertainty, Evaluation of Uncertainties for Complicated Data Reduction, Statistical Analysis of Experimental Data, Probability Distributions, The Gaussian or Normal Error Distribution, Method of Least Squares, the Correlation Coefficient, Multivariable Regression, Standard Deviation of the Mean, Graphical Analysis and Curve Fitting, Design of Experiments, Aliasing, Constructing Fractional Design, Taguchi's Design

Sensors and Transducers
Data Sampling, Signal Conditioning and Computer Data Acquisition. Error Response Characteristic of Sensors, Measurement Error

Measurement of Process Variables
Pressure Measurement: Dynamic Response, Dead Weight Pressure Tester, Bourdon Gauge; Low Pressure Measurement Techniques-the McLeod Gauge, Pirani Thermal Conductivity Gauge, Knudsen Gauge
Flow Measurement: Positive Displacement Methods, Flow Obstruction Methods, the Sonic Nozzle, Hot Wire and Hot Film Anemometer, Magnetic Flow Meter, Flow Visualization Method, LDA
Temperature Measurement: Temperature Scales, the Ideal Gas Thermometer, Temperature Measurement by Mechanical Effect, Electrical Effect, Radiation, Effect of Heat Transfer on Radiation, Transient Response of Thermal Systems, Thermocouples, and Temperature Measurement in High-Speed Flow

Measurement of Force, Torque and Power
Force Measurement: Platform Balance, Force to Displacement Conversion, Conversion of Force to Hydraulic Pressure, Piezoelectric Force Transducer
Measurement of torque and power: Torque Measurement: Electric Generator as a Dynamometer, Measurement of Rotational Speed

References
1. J. P. Holman, "Experimental methods for Engineers", McGraw-Hill.
2. R. S. Sirohi and H. C. Radha Krishna, "Mechanical Measurements", Wiley.

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2) Research/Specialization Group: 2

(Name of the Group): Manufacturing Engineering

Syllabi for: P22ME006, P22ME007, P22ME008, and P22ME009

Manufacturing Science [50 Marks]

Casting
Gating design: Aspiration effect, Effects of friction and velocity distribution, Cooling and Solidification: Mechanism of solidification, rate of solidification, solidification of large casting in an insulated mould, solidification with predominant interface resistance, solidification with constant casting surface temperature, riser design, Defects in casting and inspection of casting.

Machining
Mechanics of basic machining operation: Mechanism & mechanics of chip formation, heat generation and cutting tool temperature, failure of cutting tools and tool wear, cutting tool material, tool life and machinability, cutting fluids.

Nonconventional Machining
Mechanics of abrasive jet machining, Ultrasonic machining, Electro discharge machining, Electrochemical machining, Electron beam machining, Laser beam machining, Plasma arc machining etc. Study of process parameters, surface finish & machining accuracy.

References

1. A. Ghosh and A.K. Mallik, "Manufacturing Science", Affiliated East-West Press Private Limited.
2. A. Bhattacharyya, "Metal cutting: theory and practice", New Central Book Publisher.

Characterization Techniques and Non-Equilibrium Thermodynamics [20 Marks]

Characterization Techniques
X-ray Diffraction, X-ray fluorescence, X-ray photoelectron spectroscopy UV-Visible- IR spectroscopy, FTIR spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy, Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Impedance spectroscopy, Electronic (resistivity, Hall effect), Thermal (DTA, TGA, DSC).

References

1. R. Egerton, "Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM", Springer.
2. C. Suryanarayana and M. G. Norton, "X-Ray Diffraction: A Practical Approach", Springer.
3. J. M. Hollas, "Modern Spectroscopy", Wiley.
4. V. Balakrishnan, "Elements of Nonequilibrium Mechanics", Ane Books Pvt. Ltd.

Measurement Systems in Mechanical Engineering [30 Marks]

Measurement Systems
Generalized Description of the Measurement System, Operational Description of the General Measurement System and Elimination Method of Interfering Inputs to the Desired Inputs, Null and Deflection Methods of Measurements, Analog and Digital Measurements, Order of Instruments and Calibration, Performance Characteristics, Frequency Response

Analysis of Experimental Data
Causes and Types of Experimental Errors, Error Analysis on a Common-Sense Bias, Uncertainty Analysis and Propagation of Uncertainty, Evaluation of Uncertainties for Complicated Data Reduction, Statistical Analysis of Experimental Data, Probability Distributions, The Gaussian or Normal Error Distribution, Method of Least Squares, the Correlation Coefficient, Multivariable Regression, Standard Deviation of the Mean, Graphical Analysis and Curve Fitting, Design of Experiments, Aliasing, Constructing Fractional Design, Taguchi's Design

Sensors and Transducers
Data Sampling, Signal Conditioning and Computer Data Acquisition. Error Response Characteristic of Sensors, Measurement Error

Measurement of Process Variables
Pressure Measurement: Dynamic Response, Dead Weight Pressure Tester, Bourdon Gauge; Low Pressure Measurement Techniques- the McLeod Gauge, Pirani Thermal Conductivity Gauge, Knudsen Gauge
Temperature Measurement: Temperature Scales, the Ideal Gas Thermometer, Temperature Measurement by Mechanical Effect, Electrical Effect, Radiation, Effect of Heat Transfer on Radiation, Transient Response of Thermal Systems, Thermocouples, and Temperature Measurement in High-Speed Flow

References

1. J. P. Holman, "Experimental methods for Engineers", McGraw-Hill.
2. R. S. Sirohi and H. C. Radha Krishna, "Mechanical Measurements", Wiley.

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3) Research/Specialization Group: 3

(Name of the Group): Design and Analysis

Syllabi for: P22ME014

Mechanical Vibration [50 Marks]

Fundamentals of Vibration
Introduction, types of vibration, equations of motion for undamped free vibration, translational and torsional vibration, free damped vibration, forced vibration problems, harmonic excitation, rotating unbalance, critical speed, vibration isolation. Basics of noise, introduction, amplitude, frequency, wavelength, pressure level, noise dose level, measurement and analysis of noise.

Two Degree of Freedom Systems
Two degree undamped free vibration, Lagrangian energy method, coordinate coupling, undamped vibration absorber.

Multi Degree of Freedom Systems and Continuous Systems
Eigen value, Eigen vector, linear system, matrix method, influence coefficients, numerical methods , Rayleigh's approach, Dunkerley's method, Rayleigh-Ritz method, Duhamels integral. Transverse vibration of a string, longitudinal vibration of bar or rod, Euler equation for beams.

Vibration Measuring Instruments and Vibration Measurement
Vibration instruments, transducer, vibrometer, velometer, accelerometer, seismometer. Frequency measuring instruments, single reed, multi reed, stroboscope, vibration exciters.

References

1. L. Meirovitch, "Elements of Vibration Analysis", McGraw Hill, 2nd edition, 1986.
2. W. T. Thomson and M. D. Dahleh, Theory of Vibration with Applications, 5th edition, Pearson, 1997.

Measurement Systems in Mechanical Engineering [50 Marks]

Experimental Objectives
Monitoring, Control and Research, Systems and Variables Identifications for Mechanical Systems, Planning of Instrumentations

Measurement Systems
Generalized Description of the Measurement System, Operational Description of the General Measurement System and Elimination Method of Interfering Inputs to the Desired Inputs, Null and Deflection Methods of Measurements, Analog and Digital Measurements, Order of Instruments and Calibration, Performance Characteristics, Frequency Response

Analysis of Experimental Data
Causes and Types of Experimental Errors, Error Analysis on a Common-Sense Bias, Uncertainty Analysis and Propagation of Uncertainty, Evaluation of Uncertainties for Complicated Data Reduction, Statistical Analysis of Experimental Data, Probability Distributions, The Gaussian or Normal Error Distribution, Method of Least Squares, the Correlation Coefficient, Multivariable Regression, Standard Deviation of the Mean, Graphical Analysis and Curve Fitting, Design of Experiments, Aliasing, Constructing Fractional Design, Taguchi's Design

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Measurement of Process Variables
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Temperature Measurement: Temperature Scales, the Ideal Gas Thermometer, Temperature Measurement by Mechanical Effect, Electrical Effect, Radiation, Effect of Heat Transfer on Radiation, Transient Response of Thermal Systems, Thermocouples, and Temperature Measurement in High-Speed Flow

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References

1. J. P. Holman, "Experimental methods for Engineers",McGraw-Hill.
2. R. S. Sirohi and H. C. Radha Krishna, "Mechanical Measurements", Wiley.

Signatures and Names of DRC Members:

1. Prof. H.C. Das 1/2/23
2. Dr. D.K. Sarmah 1/2/23
3. Dr. R.N. Mahapatra (on leave)
4. Dr. P. Rangababu (ECE) 1/2/23
5. _____
6. _____

1/2/23
Signature of DRC Chairman
Date 1.2.2023

Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

(Only for the Courses relating to Research Domains for both Full Time & Sponsored Part Time)

Department: Physics

1) Research/Specialization Group: 1

(Name of the Group) Theoretical Physics

Course Code & Course Name:

PH 401: Mathematical Physics-I
PH 402: Mathematical Physics-II
PH 404: Quantum Mechanics-II
PH 505: Nuclear & Particle Physics
PH 406: Statistical Mechanics
PH 529: Non-Equilibrium Statistical Mechanics

Syllabus Content {should be an extract from the course syllabus (not the entire syllabus) which will be helpful for the research work of the scholar}:

Probability and Statistics
Definitions, simple properties, Random varibles, Binomial distribution, Poisson distribution, Normal distribution, Central limit theorem.

Complex Analysis
Analytic functions, Cauchy-Riemann equation, classification of singularities, Cauchy's theorem, Taylor and Laurent expansions, analytic continuation, residue theorem, evaluation of definite integrals.

Tensors
Tensors in index notation, Kronecker and Levi Civita tensors, inner and outer products, contraction, symmetric and antisymmetric tensors, quotient law, covariant and contravariant tensors, metric tensors, simple applications to general theory of relativity and Klein-Gordon and Dirac equations in relativistic quantum mechanics.

Approximation Methods
Time-independent approximation methods, non-degenerate perturbation theory, degenerate case, Stark effect, Zeeman effect and other examples, Variational methods, WKB method, tunnelling, Time-dependent perturbation theory.

Scattering Theory
Differential cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Greens function, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering.

Introduction to Relativistic Quantum Mechanics
Klein Gordon equation, Dirac equation, negative energy solutions, antiparticles, Dirac hole theory

Nuclear Force and Nuclear Models
Deuteron, proton-proton and neutron-neutron interaction, properties of the nuclear force, exchange force model, shell model, even–Z, even-N nuclei and collective structure, realistic nuclear models.

Particle Physics
Yukawa's hypothesis, properties of mesons, symmetries and conservation laws, Standard model, particle classification, quark model, colored quarks, gluons and strong interaction.

Statistical Description
Macroscopic and microscopic states, connection between statistical physics and thermodynamics, microcanonical ensemble, canonical ensemble and grand canonical ensemble.

Diffusion
Fick's law, Brownian motion, Langevin theory, Fokker-Planck and Smoluchowski equations.

2) Research/Specialization Group: 2

(Name of the Group)_____Smart Materials_____

Course Code & Course Name: _____PH 546: Physics of Liquid Crystals
PH 701: Characterization Techniques and Non-Equilibrium Thermodynamics

Syllabus Content {should be an extract from the course syllabus (not the entire syllabus) which will be helpful for the research work of the scholar}:

Characterization Techniques
X-ray Diffraction, X-ray fluorescence, X-ray photoelectron spectroscopy UV-Visible- IR spectroscopy, FTIR spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy, Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Impedance spectroscopy, Electronic (resistivity, Hall effect), Thermal (DTA, TGA, DSC).

Classification of Liquid Crystals
Symmetry structure and classification of liquid crystal, polymorphism in thermotropics, reentrant phenomenon in liquid crystals, blue phases, polymer liquid crystals, distribution functions and other parameters, macroscopic and microscopic order parameters, measurement of order parameters, magnetic resonance, electron spin resonance, Raman scattering and X-ray diffraction.

Theories of Liquid Crystalline Phase Transition
Nature of phase transitions and critical phenomenon in liquid crystals, hard particle, Maier-Saupe and van der Waals theories for nematic-isotropic and nematic-smectic A transitions, Landau theory, essential ingredients applications to nematic-isotropic and nematic-smectic A transitions and transitions involving smectic phases.

Continuum Theory
Curvature elasticity in nematic smectic A phases, distortions due to magnetic and electric fields, magnetic coherence length, freedeicksz transitions, field induced cholesteric nematic transition

Dynamical Properties of Nematic
The equations of nemato-dynamics, laminar flow, molecular motions, optical properties of cholesterics, optical properties of ideal helices, agent influencing the pitch, liquid crystal display.

Ferroelectric Liquid Crystals The properties of smectic C continuum description smectic C- smectic A transition applications. Discotic liquid crystals: Symmetry and structure, mean field description of discotic liquid crystals, continuum description, lyotropic liquid crystals and biological membrane. Applications of liquid crystals.

Signatures and Names of DRC Members:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____ (T. BORA)

_____
Signature of DRC Chairman

Syllabus for Comprehensive examination

Characterization Techniques

X-ray Diffraction, X-ray fluorescence, X-ray photoelectron spectroscopy UV-Visible- IR spectroscopy, FTIR spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy, Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Impedance spectroscopy, Electronic (resistivity, Hall effect), Thermal (DTA, TGA, DSC).

Classification of Liquid Crystals

Symmetry structure and classification of liquid crystal, polymorphism in thermotropics, reentrant phenomenon in liquid crystals, blue phases, polymer liquid crystals, distribution functions and other parameters, macroscopic and microscopic order parameters, measurement of order parameters, magnetic resonance, electron spin resonance, Raman scattering and X-ray diffraction.

Theories of Liquid Crystalline Phase Transition

Nature of phase transitions and critical phenomenon in liquid crystals, hard particle, Maier-Saupe and van der Waals theories for nematic-isotropic and nematic-smectic A transitions, Landau theory, essential ingredients applications to nematic-isotropic and nematic-smectic A transitions and transitions involving smectic phases.

Continuum Theory

Curvature elasticity in nematic smectic A phases, distortions due to magnetic and electric fields, magnetic coherence length, freedeicksz transitions, field induced cholesteric nematic transition

Dynamical Properties of Nematic

The equations of nemato-dynamics, laminar flow, molecular motions, optical properties of cholesterics, optical properties of ideal helices, agent influencing the pitch, liquid crystal display.

Ferroelectric Liquid Crystals The properties of smectic C continuum description smectic C-smectic A transition applications. Discotic liquid crystals: Symmetry and structure, mean field description of discotic liquid crystals, continuum description, lyotropic liquid crystals and biological membrane. Applications of liquid crystals.

31/1/2023.

Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

(Only for the Courses relating to Research Domains for both Full Time & Sponsored Part Time)

Department: Chemistry

1) Research/Specialization Group: 1

(Name of the Group) Biophysical chemistry

Course Code & Course Name:

CY 533, Biochemistry and medicinal chemistry

Syllabus Content

Peptides

Amino acids, polypeptide and protein structure, biosynthesis of amino acids, ribosome, mechanism of protein synthesis, sequencing of amino-acids in polypeptides, introduction to protein folding problems.

Nucleic acids

Classifications, nucleotides structure and their functions, biosynthesis of nucleotides, replication of DNA and RNA transcription

Enzymes and catalysis

Substrate specificity of enzymes, requirement of coenzymes, regulation of enzyme activity and allosteric effect, enzyme nomenclature, enzyme kinetics and the Michaelis-Menten equation, various types of enzyme inhibition. Application of enzymes in chemical synthesis, enzyme models and their applications

Cell membrane and molecular weight determination of biopolymers

Structure and functions of cell membrane, ion transport through cell membrane, molecular weight determination of biopolymers by various experimental techniques: sedimentation equilibrium, diffusion, sedimentation velocity, viscosity and electrophoresis.

CH 701 Analytical methods in chemistry

Optical Methods

Atomic absorption spectroscopy, steady state and time resolved fluorescence spectrometry, linear and circular dichroism, X-ray methods: X-ray absorption and X-ray diffraction, photoelectron spectroscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM) and Raman spectroscopy.

2) Research/Specialization Group: 2

(Name of the Group) Smart material

Course Code & Course Name: CH 701 Analytical methods in chemistry

Syllabus Content

Thermal Methods

Theory, instrumentation and applications of thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC), thermometric titrations.

Separation Methods

An introduction to chromatographic separations; gas chromatography: gas chromatographic columns and stationary phases, principles and applications of gas-liquid chromatography; high-performance liquid chromatography (HPLC); thin layer and column chromatography; ion-exchange chromatography; size-exclusion chromatography.

Optical Methods

Atomic absorption spectroscopy, steady state and time resolved fluorescence spectrometry, linear and circular dichroism, X-ray methods: X-ray absorption and X-ray diffraction, photoelectron spectroscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM) and Raman spectroscopy.

Structure Elucidation

Principles of UV-vis, IR, NMR and mass spectroscopy, structure elucidation of inorganic and organic molecules using spectroscopic methods.

Signature of DRC Chairman

Date 1/2/23

Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

(Only for the Courses relating to Research Domains for both Full Time & Sponsored Part Time)

Date of Comprehensive Exam: 24/02/2023

Department: EC

1) Research/Specialization Group: 1

(Name of the Group): Microelectronics & VLSI System

1. Microelectronics:

Basics of Semiconductor and device parameters. Review of physics of semiconductor. Characterization Tools used for semiconductor, Fabrication of the semiconductor devices, Photo lithography, RF and DC sputtering, XRD, FESEM, AFM, XPS, UV -visble absorption, Spin coating, Annealing, Diffusion and Ion Implantation

Basics of semiconductors, energy band diagrams, Basics of PN junction and its IV characteristics, Basics of Transistors : BJT & MOSFET and their IV characteristics, MOS Structures, basics of MEMS devices, Various transduction techniques in MEMS, Fabrication techniques for Semiconductor & MEMS Devices: ; Impurity incorporation, Oxidation, Photolithography, Thin film deposition techniques (CVD & PVD); Etching techniques.

Course Code & Course Name: MEMS and microsystem (EC 535), Concepts of Electronics and Communication (EC 701)

2. Analog and Mixed Signal system (VLSI) - Current mirror, Single ended amplifier, Differential amplifier, Cascode amplifier, Cascade Amplifier, Folded cascode, Telescopic folded cascode, OPAMP, OTA, gm/Id methodology, DAC, ADC, PLL, Machine learning Algorithms.

Course Code & Course Name: Analog VLSI (EC 502), Mixed Signal System (EC 515)

2)Research/Specialization Group: 2

(Name of the Group): Image and signal processing

1. **Signals and systems-** Classification of Signals, Operation on Continuous Signals and Discrete Signals, Properties of Signals, Classification of Systems and Properties of Systems. Properties of LTI systems, Convolution of Finite Sequences, Correlation of signals. Properties of The Fourier Transformation For Continuous- time and Discrete-Time signals, Frequency Sampling Method of Designing FIR Filters, Introduction of Laplace-transform,Properties of the Laplace transforms,Inversion of the Laplace transform,Analysis of Linear-Time-Invariant Systems using Laplace transforms. Introduction of Z- transform, Properties of the Z-TransformationsInversion of the z-transform,One-Sided Z transformationAnalysis of Linear-Time-Invariant Systems in the Z-Domain

   Course Code & Course Name: Concepts of Electronics and Communication (EC 701)

2. **Digital Image processing-**

Origin of digital image processing, human visual system and image perception,

image acquisition, display, storage, colour image fundamentals - RGB, HSI models, image

sampling, quantization, 2D transforms - DFT, DCT, KLT, SVD, DWT. Image enhancement, image

restoration, image segmentation.

Course Code & Course Name: Digital Image Processing(EC 529)

3. **Adaptive and Statistical Signal Processing**

Discrete Random Processes: Random variables, random processes, filtered random processes, ensemble averages, correlation, covariance, power spectrum, cross power spectrum, stationarity, ergodicity, time averages, Wiener-Khinchin theorem, white noise and Gaussian processes.

Digital Wiener Filtering: Minimum mean squared error (MMSE) estimation, principle of orthogonality. Wiener filters. Wiener smoothing and prediction filters, application of Wiener filters to noise cancelling, application of Wiener prediction filters. Adaptive equalization.

Least Mean Squares Adaptive Filter: Method of steepest descent, convergence speed analysis, choice of step size parameter. LMS adaptive algorithm, performance analysis of LMS adaptive filter, normalized forms, applications to adaptive equalization. Convergence analysis. Method of Least Squares: Windowing, normal equations, Riccati equations, recursive Least Squares (RLS) algorithm, complexity, performance (convergence speed, steady state mean squared error) analysis, applications to channel equalization, convergence analysis.

Course Code & Course Name: Adaptive and Statistical Signal Processing (EC 549)

3) Research/Specialization Group: 3

(Name of the Group): Microwave and Communication

1.Communication:

Wireless communications and diversity: Fast Fading Wireless Channel Modeling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Diversity modeling for Wireless communications, BER Performance Improvement with diversity, Types of Diversity – Frequency, Time, Space. Broadband wireless channel modeling: WSSUS Channel Modeling,

RMS Delay Spread, Doppler Fading, Jakes Model, Autocorrelation, Jakes Spectrum, Impact of Doppler Fading. Cellular communications: Introduction to Cellular Communications, Frequency reuse, multiple Access Technologies, Cellular Processes - Call Setup, Handover etc. MIMO: Introduction to MIMO, MIMO Channel Capacity, MIMO Spatial Multiplexing, MIMO Diversity, MIMO, OFDM. Neural Networks: Feed-forward Network Functions, Network Training, Error Backpropagation, The Hessian Matrix, Regularization in Neural Networks, Bayesian Neural Networks. Statistical Decision Theory: Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio test (LRT), receiver operating characteristics, composite hypothesis testing, locally optimum tests, generalized LRT. Estimation of Signal Parameters: Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics, maximum likelihood estimation, minimum mean square error estimation, maximum a posteriori estimation.

Course Code & Course Name: Concepts of Electronics and Communication (EC 701), wireless and mobile communication (EC 527), Machine Learning for Communications and signal processing (EC 546), Signal Detection and Estimation Theory (EC548)

2. Microwave:

Microwave Frequency bands, Applications of Microwaves: Civil and Military, Medical, EMI/ EMC. Rectangular waveguide, Concept of Mode, Characteristics of TEM, TE and TM Modes, Losses associated with microwave transmission, Concept of Impedance in Microwave transmission, Field analysis of transmission line, Coaxial Line, Circular waveguide, Stripline, Microstrip Line, CPW Line, Equivalent Voltages and currents for non-TEM lines, Network parameters for microwave Circuits, Scattering Parameters.

Review of Maxwell's Equation; Condition of radiation of electromagnetic waves and introduction to Antenna; Vector Potential and Retarded Vector Potential; Radiation fields of a Hertzian dipole(electric); Duality Principle, Radiation fields due to short magnetic dipole. Antenna Characteristics: Radiation Pattern, Beam Width; Radiation Resistance and efficiency; Directivity and Gain, Impedance, VSWR, Polarization; Effective height and Receive Aperture; Noise Temperature of Antenna. Radiation fields and Characteristics of λ/2 dipole; discussion on λ/4 monopole antenna; Current distribution and Radiation patterns of center-fed dipoles of length λ, 3λ/2 and 2 λ. Horizontal and Vertical antennas over a plane ground, design and analysis of Microstrip Patch Antenna.

Course Code & Course Name: Microwave Engineering (EC 561), Antenna Theory and Propagation(EC 540)

Syllabus Content {should be an extract from the course syllabus (not the entire syllabus) which will be helpful for the research work of the scholar}:

Signatures and Names of DRC Members:

1. _____ 4. _____
2. _____ 5. _____
3. _____ 6. _____

Signature of DRC Chairman

Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

(Only for the Courses relating to Research Domains for both Full Time & Sponsored Part Time)

Department: Electrical Engineering

1) Research/Specialization Group: 1

(Name of the Group): **Power & Energy System**

- **EE 502: Computer-Aided Power System Analysis**

Syllabus Content: Network modeling, Y-bus & Z-bus formation, power flow techniques, symmetrical domain components, unsymmetrical & symmetrical fault analysis, rotor angle stability, multi-machine swing equations, state estimation techniques, contingency analysis methods.

- **EE 504: Renewable & Distributed Energy Systems**

Syllabus Content: Renewables Resources, Microgrid, DERs, Grid connected DERs, Hydrogen Energy, Wave Technologies, Distributed Generations and associated Technologies.

- **EE 502: Power System Interconnection & Control**

Syllabus Content: P-f loop, V-Q loop, Cross-coupling between P-f loop and V-Q loop, control area, governor control, two-area power system, tie-line power flow, Load frequency control, Blackouts.

2) Research/Specialization Group: 2

(Name of the Group): Power Electronics & Drives

- **EE 503: Advanced Power Converter:**

Syllabus Content: Single-phase and three-phase controlled rectifiers, Buck, Boost, Buck-boost and Cuk converters – topology, current and voltage waveforms, voltage and current ripple. DC-AC converters: Single-phase and three-phase bridge inverters, PWM switching scheme, space vector modulation (SVPWM), Reduction of harmonics, output voltage control. Resonant Converters, the concept of zero current switching (ZCS) and zero voltage switching (ZVS).

- **EE 529: Special Electrical Machines:**

Syllabus Content: Control of PM Motor Drives Control strategies, modeling, vector control, flux-weakening operation, design of controllers, sensor-less control & rotor position estimation.

Brushless DC Motor & Permanent Magnet Synchronous Motor Drives: Construction, operation, sensing and switching logic scheme, Drive and power circuit, Theoretical analysis and performance prediction, transient Analysis.

- **EE 510: Advanced Control Systems:**

Syllabus Content: Continuous Time Systems in State-Space: Introduction of State-Space, modelling of dynamic systems. Concepts of Controllability, Observability, Sterilizability & Detectability. Design of state variable feedback, Regulator design via pole placement method, determination of full state

feedback gain using Direct-comparison method, controllable canonical form method and Ackermann's formula. state observers, Design of Full order state observers, reduced order State observers.

- **EE 504: Renewable & Distributed Energy Systems**

Syllabus Content: Renewables Resources, Microgrid, DERs, Grid connected DERs, Hydrogen Energy, Wave Technologies, Distributed Generations and associated Technologies.

Signatures and Names of DRC Members:

1. _____ 4. _____
2. _____ 5. _____
3. _____ 6. _____

Signature of DRC Chairman
Date