ECE PH.D. PRELIMINARY EXAMINATION STUDY GUIDE

Introduction

The Preliminary Exam is given each Fall (on the Monday of the Fall Semester mid-term break) and Spring semester (on the first Saturday of February). Students intending to take the exam must submit a registration form to the ECE Graduate Affairs Office by the deadline indicated on the form. The registration form is available on the ECE website. Registration for the prelim exam is open to all ECE graduate students. ECE undergraduate students with gpa's of 3.5 or higher may also register for the exam. Students admitted with the PhD classification and MS students intending to pursue the PhD degree should take the exam at the earliest opportunity.

Students classified as PhD at the time of admission must pass the PhD Preliminary Examination within their first four semesters (not counting summer sessions) in the program. Students not classified as PhD must pass the exam within two semesters of the completion of 30 hours of graduate level credit (including any transfer credits that may have been approved). Students admitted into the graduate program as MS students must pass the prelim exam to be reclassified as PhD students. All students are permitted at least three opportunities to pass the exam while enrolled in the graduate program at Georgia Tech.

The Preliminary Examination is administered in a double-blind fashion. Students taking the exam are issued code numbers by the ECE Graduate Affairs Office. Each student records their code number on the materials submitted for grading, no name is recorded on the exam materials. A score of 65% is needed in order to pass the exam.

The Preliminary Exam consists of a core examination of 16 problems taken from required and breadth courses in ECE and 9 additional problems taken from discipline-specific areas within ECE. From the 25 problems of the overall examination, each student must select eight to work and submit for grading. Students are given 4 hours to work the exam problems. The exam topics are listed in the ECE Preliminary Examination Study Guide, with courses in parenthesis that represent the scope of the material to be covered on the exam.

Preliminary Exam Content

The preliminary exam will consists of problems based upon the following areas of study:

Core exam problems:

4 problems in Computer Engineering	(ECE 2030, 2031, 3055, 3060)
2 problems in Electromagnetics	(ECE 3025, 3065)
2 problems in Analog Circuit Design	(ECE 2040, 3041, 3050)
2 problems in Electric Power Systems	(ECE 3070)
2 problems in Microsystems	(ECE 3040, 3042, 3080)
2 problems in Signal Processing	(ECE 2025, 3075)
2 problems in Systems and Controls	(ECE 3085)

Additional exam problems:

3 problems per exam in the areas of:

Software Systems and Digital Networks	(CS 2130, CS 3210, ECE 4603)
Optics & Microsystems	(ECE 4500, ECE 4501, ECE 4451, ECE 4752)
Bioengineering	(ECE 4781, ECE 4782)

For the Bioengineering additional exam problems,

Question 1 will be on the topic of biomedical instrumentation taken from ECE 4781
Question 2 will be on the topic of electrophysiology taken from ECE 4781
Question 3 will be on the topic of biological/biomedical systems from ECE 4782

The core exam course include "core" courses and "breadth" courses:

The core courses are:

ECE 2025 - Introduction to Signal Processing
ECE 2030 - Introduction to Computer Engineering
ECE 2031 - Digital Design Laboratory
ECE 2040 - Circuit Analysis
ECE 3041 - Instrumentation & Circuits Laboratory
ECE 3042 - Microelectronic Circuits Laboratory
ECE 3025 – Electromagnetics
ECE 3040 - Microelectronic Circuits
ECE 4000 - Project Engineering and Professional Practice

The EE Breadth electives must include at least 3 of the following 7 choices:

ECE 3050 - Analog Electronics
ECE 3055 - Computer Architecture & Operating Systems
or ECE 3060 - VLSI and Advanced Digital Design
ECE 3065 - Electromagnetic Applications
ECE 3070 - Electromechanical and Electromagnetic Energy Conversion
ECE 3075 - Random Signals
ECE 3080 - Semiconductor Devices
ECE 3085 - Introduction to Systems and Controls

The following pages give more details on the topics covered on the exam.

The **Bioengineering TIG** will submit three problems selected from either ECE4781 or ECE4782

ECE4781 – Biomedical Intsrumentation

Basic Concepts of Instrumentation
Static and dynamic characteristics
Design criteria
Instrumentation Amplifiers

Membrane Biophysics
Diffusion across cell membranes
Nernst potentials
Diffusion potentials
Goldman equation

Action Potentials
Membrane behavior
Origin of action potential
Hodgkin-Huxley equations
Modeling
Propagation of action potentials
Subthreshold stimuli

Biopotential Electrodes
Fundamentals
Body surface electrodes
Microelectrodes

Electrophysiology of the Heart
Anatomy/physiology of heart
Body surface potentials
Electrocardiogram
Heart vector
Standard leads

Electrophysiology of Neuromuscular System
Neuromuscular Junction
Transmitters
Poisson statistics for transmitters
Postjunctional response
Anatomy/physiology of muscle
Myofibrils and filaments
Excitation contraction
Electromyography
Functional neuromuscular stimulation

Miscellaneous Electrophysiology
Electroencephalography
Electroretinogram

Biomedical Transducers
Displacement transducers
Thermocouples and thermistors

Measurement of Blood and Gas Flows
Electromagnetic flowmeter
Ultrasonic flowmeter
Thermodilution catheter

ECE 4782 – Biosystems Analysis

A. Fundamentals of digital signals and systems
1. Convolution
2. Fourier transform
3. Digital filters

B. Fundamentals of probability and statistics
1. Probability distribution and density functions
2. Expectation and moments
3. Random processes
4. White noise
5. Correlation analysis
6. Linear Regression
7. Examples of biostatistics: independence, dependence, genetic
Counseling, false alarm

C. Modeling biological systems
1. Models of systems and the modeling process
2. Qualitative model formulation
3. Quantitative model formulation
4. Simulation paradigms
5. Numerical techniques
6. Parameter estimation
7. Model validation
8. Model analysis
9. Stochastic models
10. Nonlinear models

D. Applications/examples
1. Driver controlling speed of automobile
2. Latency characteristics
3. Pupil response
4. Electroretinogram
5. Adaptive noise cancelation
6. Neural information processing

The **Computer Engineering Technical Interest Group** will submit problems based upon the following list of topics:

Core exam (2030, 2031, 3055, 3060); 4 questions from the following topics:

Boolean algebra
number systems
combinational networks
sequential systems
digital logic modules
single-cycle and micro-coded datapath design
timing analysis (delay models, critical path, etc.)
assembly language programming
pipelined datapaths
cache
virtual memory
bus architectures and protocols
I/O

Specialized exam (CS 2130, CS 3210); 2 questions from the following topics:

data structures
algorithm design and analysis
time and space complexity
instruction dependences and code optimization
process scheduling
threads
context switching
interprocess communication and synchronization
deadlock

The **Digital Signal Processing Technical Interest Group** will submit problems based upon the following list of topics from ECE 2025 and ECE 3075.

ECE 2025 – Introduction to Signal Processing

Sinusoidal Signals [5 Lectures]
Amplitude, Phase & Frequency
Complex Exponential Representation (Phasors)
Spectrum Representation of Signals [5 Lectures]
Sinusoids, Harmonics
Other Synthesis Examples: e.g., Chirp (FM) Signals
Fourier Series: Synthesis & Analysis
Digital Signals and Sampling [5 Lectures]
Aliasing & Folding
Reconstruction from Samples
Moving Average Filters [3 Lectures]
Finite-Length Impulse Response (FIR)
Convolution
Linearity & Time-Invariance
Frequency Response [3 Lectures]
Magnitude & Phase Responses
Lowpass, Highpass & Bandpass Filters
Z-Transform Method for FIR [3 Lectures]
Zeros of the Transfer Function Polynomial
Cascading Systems
Relationship to Frequency Response
Recursive Filters [8 Lectures]
Feedback Difference Equations
Discretizing Differential Equations
Impulse Response
Z-transform for Recursive Filters
Second-Order (Narrowband) Filters
Spectrum Analysis [13 Lectures]
Fourier Transform (Continuous-Time)
Discrete-Time Fourier Transform
FFT Algorithm
Relationship between Continuous-Time and
Discrete-Time Frequency Domains
Short-Time Fourier Analysis & Spectrograms
Bandpass Filter Banks

Laboratory Modules will include: [9-10 Labs]
Introduction to MATLAB software
Manipulating Sinusoids & Complex Exponentials
Synthesis from a Spectrum (Fourier Series Analysis)
Sound and Music Synthesis
Frequency Response for Digital Filters
Filtering Applications
(e.g., AM Demodulation of Touch-Tone Phone)
Implementation of Digital Filters on DSP Chips

Image Enhancement Applications
Simulation of Differential Equations
Periodic x(t) thru Analog System: Filter the Fourier Series
Time-Frequency Analysis of Signals (Spectrogram)

ECE 3075 – Random Signals

Review of basic random variables
Notation
Probability density functions
Expectations and moments
Sample mean and variances
Bayes' rule applied to communications

Multidimensional random variables
Introduction to vector notation
Marginal and conditional probabilities
Mean and covariance vectors
Gaussian random vectors
Linear transformations
Sums of mutually independent random variables
Central limit theorem
Applications of CLT to experimental design

Poisson and point processes
Exponential and gamma densities
Poisson PMFs
Applications in packet switching
Shot noise

Simple discrete-time random sequences (repeated trials)
Bernoulli trials
Binomial, geometric, and Pascal probability mass functions
Random walk processes
Markov processes
Birth-death processes
Application to stochastic finite-state machines
Example: simulation of a queueing network
Hidden Markov models

Random processes
Mean functions
Second-order statistics
Stationarity and ergodicity
Practice computing autocorrelations
Discrete-time Gaussian processes
Continuous-time random processes

Minimum mean square estimation
Linear estimation
Gaussians, error statistics, use of simple statistics
Least squares regressions and curve fitting
MAP decision rules
Simple maximum likelihood estimation
Example of estimation of Bernoulli, Gaussian and Poisson parameters

Filtering random signals
Mean and autocorrelation of the output signal
Power density spectrum
Optimal (mmse) linear smoothers
Optimal linear predictors
Applications in signal modelling
Applications in signal restoration

Applications in packet switching
Shot noise

The **Electric Power Systems Technical Interest Group** will submit problems based upon the following list of topics:

ECE3070 – Electromechanical and Electromagnetic Energy Conversion

I. Energy: Technology and Resources
A. Energy resources: quantity and estimation of reserves
B. Fossil fuel electric energy production
C. Nuclear fuel electric energy production
D. Solar energy conversion
E. Other energy production technologies

II. Three-Phase Systems and Power Systems
A. Real and reactive power
B. Three phase systems
C. Y and Delta connections and transformations
D. Electric energy transmission and distribution systems, AC versus DC

III. Magnetic Circuits
A. Properties of magnetic materials
B. Ampere's law and magnetic circuits
C. Faraday's law and induced voltages
D. Permanent magnets
E. Induction and coupled magnetic circuits
F. Analysis and mitigation of electromagnetic noise

IV. Transformers
A. Ideal transformer
B. Physical model and equivalent circuits
C. Transformer testing

V. Electromechanical Energy Conversion
A. Electromagnetic energy storage
B. System energy conservation
C. Forces, Lorentz torque, and reluctance torque
D. Examples of simple energy conversion structures

VI. Efficiency and Process Performance
A. Losses and heat production in electrical systems
B. System efficiency and performance

VII. Sensors and Actuators
A. Electromechanical relays
B. Stepper and positioning systems
C. Switched reluctance machines
D. Synchronous reluctance machines
E. Concept of DC machines

VIII. Symmetrical AC Synchronous Machines
A. Limit the presentation to round rotor machines

B. MMF of a distributed winding and rotating magnetic fields
C. Torque in rotating machines.
D. Motor ratings and capability.
E. Equivalent circuit.

IX. Symmetrical AC Induction Machines
A. Construction and layout
B. Rotor field and slip

The **Electromagnetics Technical Interest Group** will submit two problems, one problem from ECE 3025 and the other problem from either ECE 3025 or ECE 3065.

ECE 3025 - Electromagnetics

Electrostatics
- Scalar Potential, Energy Density, Force
- Electrostatic Field of Charge Distributions
- Permittivity (Dielectric Constant)
- Boundary Conditions
- Concept of Capacitance

Electric Current
- Equation of Continuity
- Electrical Conductivity and Resistance

Magnetostatics
- Vector Potential, Energy Density, Force
- Magnetostatic Field of Current Distributions
- Permeability
- Boundary Conditions
- Concept of Inductance

Time-Varying Fields
- Faraday's Law
- Maxwell's Equations
- Energy, Power, and Poynting's Theorem
- Time-Harmonic Fields

Transmission Lines
- Lumped Circuit Models
- Transmission Line Equations
- Methods of Termination
- Pulse Excitation
- Time-Harmonic Excitation
- Lossy Lines
- Matching

PlaneWaves and Geometric Optics
- Concept of a PlaneWave
- States of Polarization
- Fresnel's Equations
- LossyMedia

ECE 3065 - Electromagnetic Applications

Transmission Lines
- Smith Chart
- Impedance Matching
- EMI Considerations

Microwave Waveguides
- General Principles
- Planar Transmission Lines
- Stripline
- Microstrip
- Rectangular Waveguides

Devices
- Resonators
- Rectangular Waveguide Cavities
- Dielectric Resonators
- S Parameters
- Directional Couplers

Radiation
- Antenna Parameters (Directivity, Beamwidth, etc.)
- Hertzian Dipole
- Wire Antennas
- Aperture Antennas
- Arrays of Elementary Antennas
- Friis Transmission Formula

The **EDA Technical Interest Group** will submit two problems based on material from the courses ECE 2040 and ECE 3050.

ECE 2040 - Circuit Analysis

Basic Concepts
- Voltage, Current, Power and Energy
- Circuit elements (R, L, C, ideal op amps, ideal transformer)
- Independent and Dependent Sources
- Kirchhoff's Laws
- Series and Parallel Combinations of Elements

DC circuit analysis
- Node Analysis
- Mesh Analysis
- Delta-Wye Transformations
- Intro to SPICE

Network Theorems
- Linearity
- Superposition
- Source Transformations
- Thevenin's Theorem
- Norton's Theorem

First and Second Order Circuits
- Singularity Functions
- RC and RL Source Free Circuits
- Constant and Non-Constant Forcing Functions
- Initial and Final Values
- RLC circuits

Sinusoidal Steady State (SSS) Analysis
- Sinusoids
- Complex Numbers, Phasors
- Impedance and Admittance
- Analysis and Network Theorems for SSS
- SPICE for SSS

Power Analysis
- Instantaneous and Average Power
- Power Factor
- Complex Power
- Maximum Power Transfer

Two-Port Networks
- Two-Port Parameters (admittance, impedance, hybrid, transmission)
- Equivalent Circuits
- Parameter Conversion
- Interconnection (series, parallel, cascade)

LaPlace Transforms

- Definition and Properties
- Convolution Integral
- Important Transform Pairs
- Inverse Transforms
- Applications to Circuit Analysis

ECE 3050 - Analog Electronics

Review

- Small-signal and large-signal models of: diodes, BJTs, JFETs, and MOSFETs

Single Stage Amplifiers

- BJT and FET single-state amplifiers.
- Biasing, voltage gain, input resistance, and output resistance.

Multi-State Amplifiers

- Differential, cascade, and cascode amplifiers.
- Biasing, voltage gain, input resistance, and output resistance.

Transfer Function Analysis

- First-order low-pass, high-pass, and shelving functions.
- Second-order low-pass, band-pass, band-reject, and biquadratic functions.
- Bode plots.
- Passive single time-constant circuits.
- Passive second-order resonant circuits.

Frequency Response of Amplifiers

- Method of short-circuit time constants for low-frequency analysis of single-stage amplifiers.
- High-frequency small-signal device models.
- Method of open-circuit time constants for the high-frequency analysis of single-stage amplifiers.

Active Filters

- Butterworth and Chebyshev filter approximations.
- Second-order Sallen-Key nd infinite-gain multi-feedback low-pass, high-pass, band-pass, and and-reject filter topologies.
- Third-order and higher-order filters.

Feedback Amplifiers

- Effects of feedback on gain, input resistance, output resistance, noise, distortion, and band-width.
- Series-shunt, shunt-shunt, series-series feedback topologies.

Non-linear Applications of Op-Amps

- Waveshaping circuits, precision rectifiers, peak detectors.

Feedback Oscillators and Function Generator Circuits

- Sinusoidal oscillators, bistable multivibrators, waveform generators.

The **Microsystems Technical Interest Group** will submit two problems for the prelim core exam based upon the material in ECE3040, ECE3042 and ECE3080. Microsystems will also submit one question from ECE4451 and ECE4752

ECE – 3040 Microelectronic Circuits

Basic Semiconductor Physics
- Bonding Mechanisms
- Charge Carriers
- Generation/Recombination
- Doping
- Carrier Transport
- Optical Absorption

PN Junctions
- Equilibrium Analysis
- Carrier Transport Under Applied Bias
- Transient Properties
- Diode Circuit Models
- Diode Applications (LEDs, Detectors)
- Diode Circuits (Limiting, Clamping, Rectifying Circuits)
- SPICE Analysis

Bipolar Junction Transistor
- Structure
- Circuit Symbol and Terminal Characteristics
- BJT Physics: Equilibrium and Under Applied Bias
- Ebers-Moll Model
- Small Signal Model
- SPICE Analysis

MOS Field Effect Transistors
- MOS Capacitor
- MOS Electrostatics
- MOSFET Structure, Symbol and Terminal Characteristics
- MOSFET Device Physics
- Circuit Models
- SPICE Analysis

Single Stage Amplifiers
- General Concepts
- Common Emitter/Source
- Common Base/Gate
- Common Collector/Drain
- Differential Amplifiers
- SPICE Analysis

Operational Amplifiers
- Inverting/Non-inverting Configurations
- First Order Circuits

Frequency Response
Non-ideal Performance

Digital Circuits
Inverter Characteristics and Circuits
Gates (AND/NAND, OR/NOR)
CMOS Inverters and Gates
CMOS and BiCMOS Logic

ECE 3042 – Microelectronic Circuits Laboratory

Terminal Characteristic of Active Devices
Transfer and Output Characteristics of BJT and MOSFET transistors
Determination of SPICE Parameters from Measured characteristics
Op-Amp Curve Tracer

Discrete Amplifiers
Common Emitter, Collector, and Base Configuration
Commons Source with JFET and MOSFET Devices
Cascode
Multistage Amplifiers
Frequency Response

Discrete Differential Amplifiers
BJT and MOSFET
Differential and Common Mode Gain
Frequency Response

Linear Op-Amp Circuits
Inverting and Non-Inverting Amplifier
T Feedback Network
Integrator and Differentiator
Peak Clipping
Output Current Limiting
Slew Rate Limiting
DC Offset and Bias Currents
Band-Pass Inverting and Non-Inverting Amplifiers
Single Power Supply Operation
SPICE Macromodels
Differential Amplifier
Instrumentation Amplifier

Nonlinear Op-Amp Circuits
Precision Rectifiers
Peak Detectors
Level Detectors

Op-Amp Active Filters
First- and Second-Order Low- and High-Pass Filters

Second-Order Bandpass Filter
Butterworth Filter
Chebyshev Filter
State Variable Filter

Switching Circuits for Digital Logic
TTL and CMOS Totem Pole Logic
Low Power Schottky-Clamped TTL
Noise Margin
Propagation Time
Power-Delay Product

Analog-Digital Interface Circuits
Clock Signal Generators
Comparators
Counters
Digital-to-Analog and Analog-to-Digital Conversion

ECE 3080 – Semiconductor Devices

Diode Operation
Equilibrium – Pierret Chapt. 5
Nonequilibrium – Pierret Chapt. 6
Nonidealities – Pierret Chapt. 6

MOS Devices
Metal-semiconductor junctions – Pierret Chapt. 14
The Field Effect – Pierret Chapt. 15
JFET/MESFET – Pierret Chapt. 15
MIS systems – Pierret Chapt. 16
MOSFETs – Pierret Chapt. 17, 18
ac response – Pierret Chapt. 17
Short channel effects – Pierret Chapt. 19

Future of Computing – On reserve in Library
CMOS limitations
Single Electron Transistors
Resonant Tunneling Devices
Quantum Dot Computing
Coupled Spin Systems
Molecular Electronics – Moletronics
Quantum Computing

Semiconductors for Communications
Optical fiber networks – class notes
Emitters – Lasers and LEDs – class notes
Detectors – APDs – class notes
Wireless systems

High Power Amplifiers for Wireless Networks, BJTs and HBTs
Future Semiconductor Devices for Wireless Applications

ECE 4451 - Semiconductor Devices for Wireless & Fiber Communication

Basics of Optoelectronics
- Semiconductor Bandstructure
- Carrier statistics
- Absorption & emission of radiation
- Generation & recombination events
- Quantum effects

Optoelectronic Emitters
- Review of p-n junctions
- Basic operating principles of LEDs and LASERs
- High speed modulation of Lasers and LEDs

Optical Detectors
- Photoconductors and MSMs
- Photodiodes and APDs
- Signal to noise ratio and optical receivers

Basics of High Frequency, High Power Electronic Devices
- Materials issues: basic carrier transport
- Transient carrier transport - velocity overshoot
- Transport in heterojunctions
- Wide band gap semiconductors

Heterojunction Bipolar Transistors
- HBT operation
- Phototransistors
- High frequency operation

Field Effect Transistors
- GaAs MESFET operation
- High Frequency MESFETs
- HEMTs

The **Optics and Photonics Technical Interest Group** will submit one problem from either ECE4500 or ECE4501.

ECE4500 – Optical Engineering

Optical Sources and Measurements
- Introduction
- Blackbody Radiator
- Line Sources / Light Emitting Diodes (LED)
- Lasers
- Coherence (Spatial Coherence/Temporal Coherence)
- Radiometry / Photometry

Geometrical Optics (Image Formation)
- Introduction
- Prisms
- Reflection and Refraction at a Spherical Surface
- Thin and Thick Lenses
- Optical Components
- Lenses, Mirrors, Prisms, Beam Splitters
- Aberrations in Optical Systems
- Optical Instruments
- Fiber Optics

Wave Optics
- Polarized Light
- Reflection and Refraction
- Brewster's Angle
- Interference
- Diffraction
- Fraunhoffer
- Fresnel
- Grating Diffraction
- Laser Doppler Velicometer

Optics of Transformations
- Optical Fourier Transforms
- Holography
- Production of Holograms
- Holographic Nondestructive Testing
- Optical Data Processing
- Pattern Recognition
- Image Enhancement
- Optical Memories

Light and Matter
- Birefringence
- Electro-optic, Magneto-optic and Acousto-optic Devices
- Optical Detectors
- Optical Recording Materials

Optical Displays
Alphanumeric Displays
Image Displays
Optical Communications Systems
Materials
Optical Displays
Alphanumeric Displays
Image Displays
Optical Communications

ECE 4501 – Fiber Optics

Review of Waveguiding Principles
- Review of Selected Topics in Optics
- Wave Equation and General Solutions
- Wave Propagation in Symmetric Dielectric Slab Waveguides

Field Solutions for Step-Index Fibers
- Weakly Guiding Approximation
- Wave Equation Solution
- Mode Description and Cutoff Conditions
- Power Confinement

Signal Degradation in Step-Index Fibers
- Absorptive, Radiative, and Scattering Losses
- Dispersion
  - Dispersion Mechanisms in Single-Mode Fiber
  - Group Delay Distortion in Multimode Fibers
  - Optical Pulse Propagation and Broadening

Power Launching and Coupling
- Gaussian Beams; Use of Lenses
- Basic Considerations for Optimum Coupling
- Coupling Efficiency Determination

Sources for Optical Communication Systems
- Basic p-n Junction Devices
- Light-Emitting Diodes; Semiconductor Lasers

Photodetectors
- PIN Photodiodes; Avalanche Photodiodes
- Response Time; Photodetector Noise

Transmission Links
- Basic System Design; System Budget Considerations
- Multiplexing Techniques
- Codes for Optical Communication Systems

Optical Networks
- Passive Components; 3 dB Couplers and Stars
- Optical Switching and Switch Architectures
- Network Architectures; Approaches to Optical Management
- Optical Amplifiers; Operation and Impact

Laboratory Characterization of Components
- Gaussian Beams

- Semiconductor Sources
- Detectors
- Fiber Loss and Dispersion

Application of Advanced Measurement Techniques and Equipment

- Optical Spectrum Analyzer
- Optical Time Domain Interferometer
- Bit Error Rate Test Set
- Eye-Diagram Analysis
- Polarization Analysis

The **Systems and Controls Technical Interest Group** will submit one problem from ECE 3085.

ECE3085 – Introduction to Systems and Control

Basic System Properties
Time Invariance, Linearity, Causality, Finite-Dimensionality

Convolution Representation
Review of Discrete-Time Convolution
Convolution for Continuous-Time Signals

Laplace Transform
Definition
Common Pairs
Properties
Inverse Laplace Transform

Transfer Function Representation
Block Diagrams
Stability
Routh-Hurwitz Stability Test
Transient Response
Frequency Response including Bode Plots

Controls
Introduction to Feedback Control
Tracking Control
Root Locus
Application to Control System Design

Discrete-Time Systems
z-Transform
Transfer Functions Representation
Stability
Discretization
Design of Digital Controllers

State Representation
State Model
Solution of State Equations
Discrete-Time Systems
Equivalent State Representation
Discretization of State Model

The **Telecommunications Technical Interest Group** will submit one problem from ECE 4603.

ECE 4603 – Communication Networks

Introduction
-Classification of Communication Networks
-Switching Methods (Circuit Switching, Packet Switching)

Physical Layer
-Transmission Media
-Digital Data Communication Techniques
-Interfacing to Physical Layer

Data Link Layer
-Introduction
-Framing Techniques
-Error Detection/Correction Techniques
-Flow Control (Stop-and-Wait, Sliding Window)
-ARQ Error Control (Stop-and-Wait, Go-Back-N, Selective Repeat Request)
-Performance Analysis of ARQ Protocols

Circuit Switching
-Circuit Switched Networks
-Switching Concepts
-Routing in Circuit Switched Networks

Network layer
-Routing
-Traffic Control

Local Area Networks
-IEEE 802.3: Bus with CSMA/CD Protocol
-IEEE 802.5: Token Ring
-Fiber Distributed Data Interface (FDDI)
-Distributed Queue Dual Bus (DQDB)
-Fast Ethernet

Transport Layer
-Transport Protocol Mechanisms
-Flow Control and Congestion Control in TCP
-Transport Control Protocol

Internetworking
-Connectionless Internetworking
-The Internet Protocol
-Routing Protocol

Overview of ATM Networks
-Basic Concepts of ATM

-Multiplexing
-Broadband Switching
-ATM Cell Structure
-ATM Layer
-ATM Adaptation Layers

Applications
-Electronic Mail (SMTP and MIME)
-Uniform Resource Locators (URL)
-Hypertext Transfer Protocol (HTTP)