EE 842/IE 854: DIGITAL SIGNAL PROCESSING

Theory Marks:	**100**	**L – T - P**
Sessional& Lab:	**75**	**4 – 0 - 1**

1. **Introduction**: Definition of signal and system, classification of signals, basic elements of digital signal processing, advantages of digital over analog signal processing, concept of frequency in continuous- time (CT) and discrete- time (DT) signals, elementary DT signals, classification, representation of DT systems, analysis of DT-LTI systems and its properties, DT system described by difference equations, sampling and reconstruction of signals.

2. **Frequency Analysis of DT Signals**: Fourier series and power density spectrum, Fourier transform and energy density spectrum, Fourier transform properties, Frequency-domain characteristics of LTI systems, LTI systems as Frequency-Selective Filters, Invertibility of LTI systems.

3. **Discrete Fourier Transform (DFT)**: DFT and its properties, DFT as a Linear Transformation, circular convolution, relationship of the DFT to other transforms, frequency analysis of signals using DFT.

4. **Fast Fourier Transform (FFT)**: FFT algorithms and its applications, linear filtering approach to computation of the DFT, quantization effects in the computation of the DFT.

5. **Implementation of DT Systems**: Structures for FIR and IIR Systems, State-space system analysis and structures, quantization of filter coefficients, round-off effects in digital filters.

6. **Design of Digital Filters**: General considerations, FIR and IIR filter design, computer aided design techniques.

References:

1. Proakis, J. G. and Manolakis, D. G., **Digital Signal Processing: Principles, Algorithms and Application**s, 3rd Edition, Prentice Hall of India.
2. Oppenheim, A. V. and Schafer, R. W., **Discrete Time Signal Processing**, Prentice Hall of India.
3. Roberts, M. J., Signals and Systems, Tata McGraw Hill.
4. Mastering MATLAB, Pearson Education (for laboratory use).

L T P
(3 1 0)

EE 843: INDUSTRIAL DRIVES AND CONTROL

Full marks: Theory = 100
Sessional=75

Time: 3 hours

1. **Dynamics of Electric drives:**

Classification of electric drives, types of load, speed-torque characteristics of loads and motors, selection of motors, dynamics of motor- load combination, four-quadrant operation, moment of inertia, steady state and transient stabilities of electric drives.

2. **Characteristics of motors**:

Review of the speed-torque characteristics of the important AC and DC drive motors.

3. **Starting:**

Effect of starting on power supply, motor and load, starting method of automatic alerting circuits, time and current limit acceleration, energy relations and reduction of energy loss during starting, master controllers.

4. **Electric braking**:

Braking methods, speed-torque characteristic under braking conditions, energy relations and reduction of energy loss during braking.

5. **Rating of motors:**

Heating: Heating and cooling of motors, loading condition and classes of duty, power rating and selection of motors for different applications, load inertia and load equalization.

6. **Mechanical Features for Electrical Motors:**

Types of enclosures, bearings, mountings and transmission of drive, reduction of noise.

7. **Thyristorised DC motor Drives:**

Speed equations and performance characteristics of DC motors, single phase and three phase controlled converter drives, dual converter schemes, two/four quadrant chopper drives, regenerating braking with DC series motor fed from a chopper, closed loop control.

8. **Industrial application of electric motors**:

Important processes, requirements of drives and types of motors used in rolling mills, pulp and paper mills, cement mills, sugar mills, and coal mining, machine tool drives.

9. **Thyrisorised AC motor drives:**

Speed equations and performance characteristics of three phase induction motors, induction motor drives using thyristors for static voltage control, slip-power recovery and rotor resistance control, variable frequency operation of three-phase induction motors with constant flux and torque. Inverter/cycloconverter control of induction and synchronous motors, closed-loop control.

Books/References:

1. Pillai, S.K.: Afirst Course in Electric Drives- Wiley Eastern
2. Partab,h.: Art and science of utilization of electric energy-Dhanpat Rai & Sons.
3. Chilkin, M.: Electric drives—Mir publishers, Moscow.
4. Rashid ,M.H.: Electronics-Prentice hall of India.
5. Subramanium,V.: Thyristor control of Electric motors-TMH
6. Vicker, H.: Induction motor-McGraw Hill.

EE 846: Project-II (0-6-0)
Max Marks: 150

This subject has two components. The first is sessional, under which a project work has to be taken up on a relevant topic to be decided by the student in consultation with the supervisor. The project is to be done in a group, which may consist of two, three or four students. The project may be a software, a hardware or a study type project.

The students have to submit a project proposal and/or justify the relevance of the topic in a project proposal seminar at the beginning of the semester, after approval of which only a student can take up that project. The students also have to give a presentation of their progress in a seminar. At the end, the students have to submit a report and present their works in a seminar.

The second component of the subject is the End Semester Examination for which a seminar and viva-voce examination will be held at the end of the semester after the satisfactory completion of the project work. .

EE 841: POWER SYSTEM INTERCONNECTION AND CONTROL
(3-1-0)

Full marks:

Theory—100

Sessional--75

Time—3 hrs

1. **Economic Operation Of Thermal plants**:

Methods of loading turbo-generators, input-output curves, heat ratio and incremental cost, co-ordination equation, economic loading of units, with and without transmission loss, penalty factor, iterative methods of solving co-ordination equation, economic thermal dispatching with network losses considered, B-matrix loss formula and its derivatives, economic dispatch versus unit commitment(UC), constraints in UC, UC solution method, optimal load flow solution, power system security, introduction to load forecasting.

2**. Hydrothermal co-ordination:**

Advantages of combined operation , base load and peak load consideration , combined operation of run-off river and thermal plants , hydro electric plant models, scheduling problems, short-term hydro-thermal scheduling, long-term

aspects of hydro and thermal plants, co-ordination equations in hydro-thermal operations, use of dynamic programming in hydro-thermal scheduling.

3. **Power system Interconnection**:

Introduction, types of interconnections and their advantages, tie-line control in interconnected systems, economics of interconnected systems, estimation, economic dispatch calculation for interconnected systems, transmission losses in interconnected systems.

4. **Automatic generation and voltage control:**

Introduction , reactive power requirements in peak and off-peak hours, real and reactive power control, effect of real power on system frequency , automatic excitation control, reactive power injection and use of tap changing and regulating transformers, use of models in the control of generation (generator, load, prime-movers, governor and tie-line models),generator allocation, automatic generation control(AGC), AGC features.
Load frequency problem, load frequency control(LFC) for single area case , equipments for LFC, LFC and economic dispatch control, two area control, optimal LFC, LFC with generation rate constraints(GRCs), speed governing systems, speed governor dead band and its effect on AGC.
Introduction to neural networks, fuzzy logic control.

5. **State estimation in power systems:**
Introduction, maximum likelihood weighted least-square estimation.

6. **Introduction to the IEEE study model of an interconnected power system.**

BOOKS

1. Wood and Wollenburg: Power generation, operation and control—John Wiley and sons.

EE 844/IE 854: RELIABILITY ENGINEERING (Elective)

Theory Marks: 100
Sessional Marks: 75

L	T	P
4	0	0

1. **Introduction to Reliability Engineering**: Definition of reliability, reasons for reliability engineering programmes, applications and benefits, reliability and cost, reliability and quality, definition of availability and maintainability.

2. **Reliability Mathematics**: Basic probability theorems, rules for combining probabilities-independent events, mutually exclusive events, complementary events, conditional events, simultaneous occurrence of events; Random variables-discrete and continuous, their properties; Data reduction to frequency histograms and polygons, frequency distribution and probability density function, failure probability density function and its estimate, cumulative frequency and cumulative distribution, data and distribution descriptive values-central tendencies (mean, mode and median), distribution moments, variance and standard deviation, coefficient of variation, skewness, kurtosis, fractiles, percentiles and quantiles, distribution parameters-location, shape and scale parameters; Standard distributions-discrete and continuous, discrete-Binomial and Poisson distributions, continuous-exponential, normal, log-normal, Rayleigh, Weibull, Gamma and extreme-value distribution.

3. **Concepts of Reliability**: Definition of reliability; Failure- causes of failures, modes of failures, life characteristics pattern (Bath-tub curve); Measures of reliability-failure rate, mean time between failure (MTBF), mean time to failure (MTTF), derivation of reliability function and its properties, relationship between density function, distribution function, reliability and failure rate; Hazard rate function-constant hazard model, linear hazard model; Reliability evaluation at component level; Probability plotting.

4. **System Reliability Evaluation**: Reliability block diagram; Systems-series, parallel, series-parallel, parallel-series, k-out-of-m system, standby system; Complex system- decomposition technique, tie set and cut set method, Boolean truth table method; Fault tree and Event tree method; Redundancy technique in system design-component versus unit redundancy, weakest link technique, mixed redundancy, standby redundancy.

5. **Availability Analysis**: Markov process and general concept of modeling; Instantaneous and Steady-state availabilities; State-space diagram; Markov model for-two repairable components, three repairable components, standby redundant system, non-repairable system; Stochastic transitional probability matrix; Steady-state availability calculation of systems.

6. **Maintained Systems**: Maintenance, objectives of maintenance, forms of maintenance, types of maintenance; Preventive maintenance-idealized maintenance, effect of preventive maintenance on reliability; Corrective maintenance; Definition and derivation of Maintainability function.

7. **Economics of Reliability Engineering**: Economic issues, manufacturer's cost, customer's cost, reliability achievement cost models, reliability utility cost models, depreciation-cost models; availability-cost model for parallel systems.

References:

1. Reliability Engineering - E. Balagurusamy, Tata McGraw Hill Publishing Comp. Ltd., 1984.
2. Reliability Engineering – A. K. Govil, Tata McGraw Hill Publishing Comp. Ltd., 1983.
3. Introduction to Reliability Engineering- E. E. Lewis, John Wiley and Sons, 1996.
4. Reliability Engineering Handbook (Vol 1) – Dimitri Kececioglu, Prentice Hall PTR, 1991.
5. Reliability Evaluation of Engineering Systems-concepts and techniques-Roy Billinton and Ronald N. Allan (2nd Edition), Plenum Press, 1992.
6. Probabilistic Reliability- an engineering approach- M. L. Shooman, McGraw Hill Book Company, 1968.

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EE 847: Viva-Voce

The viva-voce examination will be held at the end of the semester. Those students who have successfully completed their project works can only appear in this examination. The viva voce examination will cover the entire syllabus of Electrical engineering of B.E. course.

EE 844/IE 854: Digital Image Processing (Elective)

L	T	P
4	1	0

Max Marks: 100
Sessional: 75
Time: 3 hours

Human Visual System and Image perception; Monochrome and colour vision models; Image acquisition and display; Video I/O devices; Standard video formats; Image digitization; display and storage; 2D signals and systems;

Image Transforms: 2D, DFT, DCT, Harr transform;

Image enhancement: Some simple intensity transformations, Histogram processing; Image subtraction; Image averaging.

Spatial filtering: Background; Smoothing filters; Sharpening filters.

Image Restoration: Degradation Model; Inverse filtering; Least mean square (Wiener) Filter.

Image Compression: Lossy Compression; Lossless Compression.

Image Segmentation: Detection of discontinuities; Edge linking and Boundary Detection; Thresholding;

Representation and Description: Representation schemes; Boundary descriptors; Regional descriptors; Morphology.

Applications of Digital Image Processing

Books:

1) Funndamentals of Digital Image Processing, A.K.Jain, Pearson Education.
2) Digital Image Processing, R.C.Gonzalez & R.E.Woods, Perason Education.
3) Digital Image Processing with MATLAB, R.C.Gonzalez & R.E.Woods, S.L.Eddins, Pearson Education.

EE 844/IE854: Expert Systems (Elective) (4-1-0)

Theory: 100 Marks
Sessional: 75 Marks

Theory of Expert Systems:, Rule Based Systems, Forward & Backward Chaining, Matching, Partial Fuzzy Matching, Rate Algorithm, Handling Uncertainty, Uncertainty Factor, Bayesian Methods, Dempster –Shafer Theory, Fuzzy Logic, Model & Temporal Logic, Truth Maintenance, Default Reasoning, Structural Representation Systems_Frames, Semantic Nets, Object Based, Scripts, Indexing, Retrieval Technique, Learning, Expert System Shells, Expert System Development Cycle, Debugging Knowledge Bases, Expert System Tools.

Books:

1) P. Jakson- Introduction to Expert Systems, Addison Wesley.
2) D.W. Ralston- Principles of Artificial Intelligence& Expert Systems, McGraw Hill.
3) B. Buchanaen & E. Shorteiffe—Rule Based Expert Systems.
4) L. Brownston__Programming Expert Systems in OPSS, Addison Wesley.

EE 844/IE 854: RELIABILITY ENGINEERING (Elective)

Theory Marks: 100
Sessional Marks: 75

L	T	P
4	0	0

8. **Introduction to Reliability Engineering**: Definition of reliability, reasons for reliability engineering programmes, applications and benefits, reliability and cost, reliability and quality, definition of availability and maintainability.

9. **Reliability Mathematics**: Basic probability theorems, rules for combining probabilities-independent events, mutually exclusive events, complementary events, conditional events, simultaneous occurrence of events; Random variables-discrete and continuous, their properties; Data reduction to frequency histograms and polygons, frequency distribution and probability density function, failure probability density function and its estimate, cumulative frequency and cumulative distribution, data and distribution descriptive values-central tendencies (mean, mode and median), distribution moments, variance and standard deviation, coefficient of variation, skewness, kurtosis, fractiles, percentiles and quantiles, distribution parameters-location, shape and scale parameters; Standard distributions-discrete and continuous, discrete-Binomial and Poisson distributions, continuous-exponential, normal, log-normal, Rayleigh, Weibull, Gamma and extreme-value distribution.

10. **Concepts of Reliability**: Definition of reliability; Failure- causes of failures, modes of failures, life characteristics pattern (Bath-tub curve); Measures of reliability-failure rate, mean time between failure (MTBF), mean time to failure (MTTF), derivation of reliability function and its properties, relationship between density function, distribution function, reliability and failure rate; Hazard rate function-constant hazard model, linear hazard model; Reliability evaluation at component level; Probability plotting.

11. **System Reliability Evaluation**: Reliability block diagram; Systems-series, parallel, series-parallel, parallel-series, k-out-of-m system, standby system; Complex system- decomposition technique, tie set and cut set method, Boolean truth table method; Fault tree and Event tree method; Redundancy technique in system design-component versus unit redundancy, weakest link technique, mixed redundancy, standby redundancy.

12. **Availability Analysis**: Markov process and general concept of modeling; Instantaneous and Steady-state availabilities; State-space diagram; Markov model for-two repairable components, three repairable components, standby redundant system, non-repairable system; Stochastic transitional probability matrix; Steady-state availability calculation of systems.

13. **Maintained Systems**: Maintenance, objectives of maintenance, forms of maintenance, types of maintenance; Preventive maintenance-idealized maintenance, effect of preventive maintenance on reliability; Corrective maintenance; Definition and derivation of Maintainability function.

14. **Economics of Reliability Engineering**: Economic issues, manufacturer's cost, customer's cost, reliability achievement cost models, reliability utility cost models, depreciation-cost models; availability-cost model for parallel systems.

References:

7. Reliability Engineering - E. Balagurusamy, Tata McGraw Hill Publishing Comp. Ltd., 1984.
8. Reliability Engineering – A. K. Govil, Tata McGraw Hill Publishing Comp. Ltd., 1983.
9. Introduction to Reliability Engineering- E. E. Lewis, John Wiley and Sons, 1996.
10. Reliability Engineering Handbook (Vol 1) – Dimitri Kececioglu, Prentice Hall PTR, 1991.
11. Reliability Evaluation of Engineering Systems-concepts and techniques-Roy Billinton and Ronald N. Allan (2nd Edition), Plenum Press, 1992.
12. Probabilistic Reliability- an engineering approach- M. L. Shooman, McGraw Hill Book Company, 1968.

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EE 845: High Voltage Engineering (Elective) L T P

4 1 0
Theory Marks: 100
Sessional Marks: 75
Time: 3 Hours

1. **Conduction and Breakdown in Gases**:

Desirable properties of gas and insulating medium, Townsend's current growth equations, Townsend's criterion for breakdown, Electronegative gases and their breakdown, Streamer theory, Baschen' s law.

2. **Conduction and Breakdown of liquid Dielectrics**:

Pure and commercial liquids, origin and purification, breakdown of commercial liquids, Transformer oil- composition, properties and deterioration: Inhibitor.

3. **Breakdown of solid Dielectrics**:

Different types of breakdown, measurement of intrinsic strength, partial discharge.

4. **Electrical Properties of High Vacuum**:

High Vacuum as dielectric, breakdown conduction, factors affecting breakdown voltage, breakdown phenomenon.

5. **Lighting Over-voltage**:

Measuring instruments, Magnetic surge crest ammeter, Kyldonograph, Fulchronograph, Oscillograph, Protective devices, surge absorbers, ground and counterpoise wires, lighting arresters, switching over voltages- origin, wave shape and magnitudes, protective devices.

6. **High-voltage Generation**:

Alternating voltage: transformers in cascade, single units, high frequency transformers, direct voltage: Voltage multipliers and cascade circuits using rectifiers, electrostatic machines, voltage stabilization, transient voltage, impulse generator, analysis of the basic circuits, standard impulse wave-shape, multi-stage circuits, wave shape control, triggering, general construction, synchronization with oscilloscope.

7. **High-voltage Measurement**:

Measurement of high direct, alternating (rms and peak) and impulse voltage and currents. Uniform field electrodes, measurement of dielectric constant and loss factor, Schering bridge, Wagner earth discharge and measurement.

8. **High-voltage Testing**:

Low-frequency tests, impulse tests, test circuits, control gear, testing of overhead line insulators, cables and transformer oil.

9. **High-voltage Equipment**:

Bushings: classification, construction and application, Grading, Breakdown of bushings, design and constructional features of high-voltage resistors, High-voltage capacitors, guard rings and shields.

10. **High-voltage Laboratory**:

Planning, testing and other facilities, test equipment, clearance and layout safety measures, grounding, High-voltage connections.

References:

1. Kuffel E. and Abdulla , M., 'High Voltage Engineering', Paragon Press, London.
2. Naidu, M. S., and Karmaju, V., 'High Voltage Engineering', Tata Mc Grow Hill.
3. Chourasia, M. P., 'High Voltage Engineering', Khanna publishers.
4. Alsten, 'High Voltage Engineering'.
5. Jha, R., A. S., 'High Voltage Engineering', Dhanpat Rai & Sons.
6. Rind , D. 'High Voltage Laboratory Technics, PHI.

EE 845: Utilization & Conservation of Electrical Energy (Elective)

(4-1-0)

Max Marks: 100
Sessional: 75
Time: 3 hours

1) Electric Heating:-

Advantages, Classification, Resistance Heating, Furnaces, Requirements and Design of heating elements, Temperature control, Electric arc furnaces, Direct & Indirect, Construction & Operation, Electrodes & Power Supply, High Frequency Heating, Induction Heating, Working principle, Power & High frequency Heating, Choice of Frequency, Core type & Coreless Furnaces, Skin Effect & Pinch effect, High Frequency Supply, Advantages & Disadvantages, Dielectric Heating, Working principle, Choice of Voltage and Frequency, Advantages & Applications.

2) Electric Welding:-

Classifications, Resistance Welding:: Spot, Butt, Seam. Arc welding:: types, electrode used, power sources and control circuits. Atomic hydrogen welding. Modern development.

3) Electric traction:-

Advantages. Systems of electric traction. Choice of system voltage and frequency. The Indian scenario. Types of train services. Train movements and energy consumption.speed-time, distance-time and energy consumption curves.Tractive effort, Adhesion, Train resistance. Power supply arrangements. Substation equipment. D.C AND A.C. traction motors, their disposition and operation on tram cars, motor coaches and locomotives. Control systems; Rheostatic, field control and series-parallel using shunt and bridge transition methods. Multiple unit control. Metadyne control. Controllers for dc & ac traction motors. Tram Cars, Motor coaches, & Trolly Buses. Auxiliary Electrical Equipments for Tram cars, Motor Coaches & Locomotives. Braking:: mechanical, vacuum & electrical.

1) Energy Storage:-

Size & Duration of storage. Modes of energy storage::mechanical,
electrical, magnetic, thermal & chemical. Comparison of the different systems.

2) Electrical Losses & Energy Conversion:-

Electrical transmission, distribution & utilization losses. Classification. Reduction of losses. Benefits of electrical energy conservation. Energy conservation in lighting, electric furnaces, electric drive, traction systems. Use of energy –efficient equipment.

6) Electrical Energy Audit:-

Introduction, benefits, procedure for energy audit. Instruments for energy audit. Methodology. Case study.

Books:-

1) Tripathy, S.C ; Electrical Energy Utilization & Conservation, TMG
2) Suryanarayan, N.V. ; Utilization of Electric power ; Wiley Eastern Ltd.
3) Pratab, H.; Utilization of Electrical Energy; Dhanpat Rai & Sons.