Name of Specialization: Control & Instrumentation

No. of Question: 50 (Objective Type)

Duration: 1 Hr. 30 Min Maximum Marks:50

1. MODERN CONTROL SYSTEM

State variable analysis and design: State space model for continuous time linear system and discrete time linear system. State space representation using phase variables and canonical variables, transfer function from state model, state model from transfer function, diagonalization Eigen values and eigen vector, solution of state equation. Controllability, observability and reproducibility, controllable companion transformation, interpretation of controllability, observability criteria, duality, output function controllability, input function observability. State feedback control. State feedback and output feedback, pole assignment using state feedback and output feedback, reconstructing the state from available outputs. Analysis of state equations, Control law design for full state feedback, Selection of pole locations for good design, Estimator design, Combined control law and Estimator loop transfer recovery, Integral control and robust tracking, Design of systems with pure time delay.

2. DIGITAL SIGNAL PROCESSING

DFT & its properties. Decimation in time and decimation in frequency FFT algorithms, discrete cosine transform. IIR Filter design: Butterworth design, bilinear transformation. Low Pass, High Pass, Band Pass and Band Stop digital filters. Spectral transformation of IIR filters. FIR filter design: Symmetric and antisymmetric linear phase. FIR filter by rectangular, triangular and Blackman window functions. Finite word length effects in FIR and IIR digital filters: Quantization, round off errors and overflow errors. Multi rate digital signal processing: Concepts, design of practical sampling rate converters, Decimators, interpolators. Polyphase decompositions.

3. BIOMEDICAL ELECTRONICS

Brief introduction to human physiology. Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases. Bio electrodes and bio potential amplifiers for ECG, EMG, EEG, etc. Measurement of blood temperature, pressure and flow. Impedance plethysmography. Ultrsonic and nuclear imaging. Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects. Telemetry – Transmission of the original through wire & wireless. Imaging techniques – Ultrasound, CAT, X-Rays, PET, NMR, Nuclear. Physiological effect of electric current, safety. Cardiological Signal Processing: Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG parameters & their estimation, the use of multi scale analysis for parameters estimation of ECG waveforms, Arrhythmia analysis, monitoring, long form continuous ECG recording. ECG data reduction technique, Direct data

compression techniques, Direct ECG data compression techniques.

Transformation compression techniques. Other data compression techniques. Data compression techniques, comparison.

4. ARTIFICIAL NEURAL NETWORKS

Introduction: Biological neurons and memory; Structure and function of a single neuron, artificial neural networks (ANN), typical applications of ANNs; classification, clustering, vector quantization, pattern recognition, function approximation, forecasting, control optimization, basic approach of the working of ANN – training, learning and generalization.

Supervised Learning: Single layer networks, perceptron-linear separability, training algorithm, limitations; multi-layer networks architecture, back propagation algorithm (BTA) and other training algorithms, applications, Adaptive multi-layer networks-architecture, training algorithms, recurrent networks, feedforward networks, radial-basis function (RBF) networks. Unsupervised Learning: inner-takes-all networks, hamming networks, maxnet, simple competitive learning, vector-quantization, counter propagation networks, adaptive resonance theory, Kohonen's Self organizing maps, principal component analysis. Associated Models: Hopfield Networks, brain-in-a-box network, Boltzmann machine. Optimizing Methods: Hopfield Networks for TSP, solution of simultaneous linear equations, Iterated gradient descent, simulated annealing, genetic algorithm.