RECRUITMENT TO THE POST OF ASSITANT ENGINEER (ELECTRICAL)

IN THE OFFICE OF THE CHIEF ENGINEER,

WATER RESOURCES DEPARTMENT, MEGHALAYA

Syllabus for Written Examination

PART I – GENERAL ENGLISH (100 Marks)

PART II – GENERAL KNOWLEDGE (100 Marks)

PART III – ELECTRICAL ENGINEERING

(OBJECTIVE - PAPER I = 50 MARKS, PAPER II = 50 MARKS)

ELECTRICAL ENGINEERING

PAPER-I

1. Electrical Circuits-Theory and Applications: Circuit components; network graphs; KCL, KVL; circuit analysis methods: nodal analysis, mesh analysis; basic network theorems and applications; transient analysis: RL RC and RLC circuits; sinusoidal steady state analysis; resonant circuits and applications; coupled circuits and applications; balanced 3- phase circuits. Two-port networks, driving point and transfer functions; poles and zeros of network functions. Elements of networks synthesis. Filter-theory: design, and applications. Active filters. Circuit simulation: Input formats; methods of education formulation; solution of equations; output formats; SPICE.

2. Signals & Systems: Representation of continuous-time and discrete-time signals & systems; LTI systems; convolution; impulse response; time-domain analysis of LTI systems based on convolution and differential/difference equations. Fourier transform, Laplace transform, Z-transform, Transfer function. Sampling and recovery of signals DFT, FFT Processing of analogy signals through discrete-time systems.

3. E.M. Theory: Maxwell's equations, wave propagation in bounded media. Boundary conditions, reflection and refraction of plane waves. Transmission line: Distributed parameter circuits, travelling and standing waves, impedance matching, Smith chart. Waveguides: parallel plane guide, TE, TM and TEM waves, rectangular and cylindrical wave guides, resonators. Planar transmission lines; strip line, microstripline.

4. Analog Electronics: Characteristics and equivalent circuits (large and small-signal) of Diode, BJT, JFET and MOSFET. Diode circuits: clipping, clamping, rectifier. Biasing and bias stability. FET amplifiers. Current mirror; Amplifiers: single and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency-response of amplifiers. OPAMP circuits. Filters; sinusoidal oscillators: criterion for oscillation; single-transistor and OPAMP configurations. Function generators and wave-shaping circuits. Power supplies.

5. Digital Electronics: Boolean algebra; minimisation of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and. shift-registers. Comparators, timers, multi-vibrators. Sample and hold circuits, ADCs and DACs. Semiconductor memories. Logic implementation using programmable devices (ROM, PLA, FPGA).

6. Energy Conversion: Principles of electromechanical energy conversion: Torque and emf in rotating machines. DC machines: characteristics' and performance analysis; starting and speed control of motors.

7. Transformers: Principles of operation and analysis; regulation, efficiency; 3-phase transformers. 3-phase induction machines and synchronous machines: characteristics and performance analysis; speed control. Special machines: Stepper motors, brushless dc motors, permanent magnet motors single-phase motors; FHP.

8. Power Electronics and Electric Drives : Semiconductor power devices ; diode, transistor, thyristor, triac, GTO and MOSFET-static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters : fully-controlled and half-controlled; principles of thyristor choppers and inverters; basic concepts of speed control of dc and ac motor drives applications of variable-speed drives.

9. Analog Communication: Random variables - continuous, discrete; probability, probability functions. Statistical averages; probability models; Random signals and noise: white noise, noise equivalent bandwidth; signal transmission with noise; signal to noise ratio. Linear CW modulation: Amplitude modulation: DSB, DSB-SC and SSB. Modulators and Demodulators; Phase and Frequency modulation: PM & FM signals; narrowband FM; generation & detection of FM and PM, Deemphasis, Preemphasis. CW modulation system: Superhetrodyne receivers, AM receivers, communication receivers, FM receivers, - phase locked loop, SSB receiver Signal to noise ratio calculation or AM and FM receivers.

10. Microwaves and Antenna: Electromagnetic radiation, Propagation of waves: ground waves, sky wave, space wave, tropo spheric scatter propagation. Extraterrestrial communications. Antenna: Various types, gain, resistance, band-width, beam width and polarization, effect of ground. Antenna coupling; high frequency antennas; microwave antennas; special purpose antennas. Microwave Services: Klystron, magnetron, TWT, gun diodes, Impact; Bipolar and FETs, Microwave integrated circuits. Microwave measurements.

PAPER-II

1. Control Systems: Elements of control systems; block-diagram representation; open-loop & closed-loop systems; principles and applications of feed-back. LTI systems: time-domain and transform-domain analysis. Stability: Routh Hurwitz criterion, root-loci, Nyquist's criterion, Bode-plots, Design of lead-lad compensators. Proportional, PI, PID controllers. State-variable representation and analysis of control systems. Principles of discrete-control systems.

2. Electrical Engineering Materials: Electrical/electronic behaviour of materials: conductivity; free-electrons and band-theory; intrinsic and extrinsic semiconductor, p-n junction; solar cells, super-conductivity. Dielectric behaviour of materials; polarization phenomena; piezo-electric phenomena. Magnetic materials behaviour and application. Photonic materials: refractive index, absorption and emission of light, optical fibres, lasers and opto-electronic materials.

3. Microprocessors arid microcomputers: 8 - bit microprocessor: architecture, CPU, module design, memory interfacing, I/O, Peripheral controllers, Multiprocessing. IBM PC architecture: overview, introduction to DOS, Advanced microprocessors.

4. Measurement and Instrumentation: Error analysis; measurement of current voltage, power, energy, power-factor, resistance, inductance, capacitance and frequency; bridge measurement. Electronic measuring instruments: multimeter, CRO, digital voltmeter, frequency counter, Q-meter, spectrum-analyser, distortion-meter. Transducers: thermocouple, thermistor, LVDT, strain-guage, piezoelectric crystal. Use of transducers in measurements of non-electrical quantities. Data-acquisition systems.

5. IC Technology: Overview of IC Technology. Unit-steps used in IC fabrication: wafer cleaning, photo-lithography, wet and dry etching, oxidation, diffusion, ion-implantation, CVD and LPCVD techniques for deposition of poly-silicon, silicon, silicon-nitride and silicon dioxide; metallisation and passivation.

6. Power Systems : Analysis and Control : Steady-state performance of overhead transmission lines and cables; principles of active and reactive power transfer and distribution; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults. Concept of system stability: swing curves and equal area criterion. Static VAR system. Basic concepts of HVDC transmission; FACTS. Computer control and Automation: Introduction to energy control centres; various states of a power system; SCAD A systems and RTUs. Active power control: Speed control of generators, tie line control, frequency control. Economic dispatch

7. Power system protection: Principles of over current, differential and distance protection. Concept of solid stale relays. Circuit brakers. Computer aided protection : Introduction; line bus, generator, transformer protection; numeric relays and application of DSP to protection.

8. Non-conventional Energy Sources and Energy Management: Introduction to the energy problem; difficulties with conventional energy sources. Wind-Energy: Basics of Wind turbine aerodynamics; wind-energy conversion systems and their integration into electrical grid. Solar-Energy: Thermal conversion: photo-voltaic conversion. Wave-energy. Importance of Energy Management: Energy audit; energy economics: discount rate, payback period, internal rate of return, life cycle costing.

9. Digital Communication: Pulse code modulation (PCM), deferential pulse code modulation (DPCM), delta modulation (DM), Digital modulation and demodulation schemes: amplitude, phase and frequency keying schemes (ASK, PSK, FSK). Error control coding: error detection and correction, linear block codes, convolution codes. Information measure and source coding. Data networks, 7-laycr architecture.

10. Satellite Communication, Radar and TV: Satellite Communication: General overview and technical characteristics. Earth station equipment, satellite link design, CNR of Satellite system. Radar: Basic principles. Pulsed systems: CW Doppler radar, FMCW radar. Phase array radars. Television Systems: Television systems and standards, Black-and White-and Colour-TV transmission and receiver systems.

11. Fibre Optic System: Multiplexing - Time division multiplexing. Frequency Division multiplexing. Optical properties of materials: Refractive index absorption and emission of light, optical fibres, lasers and optoelectronic materials Fibre optic links:

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