PRACTICE QUESTION PAPER — SET 1

PHY-M-T-13: Electronics - II

Full Marks: 40 **Time: 2 Hours**

Answer all questions. The figures in the margin indicate full marks. Symbols have their usual meanings.

1. **Answer any four questions:** **[2 × 4 = 8]**

   (a) Define line regulation and load regulation of a regulated power supply.

   (b) Distinguish between a DIAC and a TRIAC in terms of terminal structure and triggering characteristics.

   (c) Define Neper and Decibel, and state the mathematical conversion relation between them.

   (d) What is the modulation index in Amplitude Modulation (AM)? State the condition for over-modulation.

   (e) Define Voltage Standing Wave Ratio (VSWR) and write its relation with the reflection coefficient Γ.

2. **Answer any four questions:** **[4 × 4 = 16]**

   (a) Explain the working of a series voltage regulator using a BJT and an Operational Amplifier, deriving the expression for its regulated output voltage.

   (b) Describe the planar process for the monolithic fabrication of a Bipolar Junction Transistor (BJT) on a silicon substrate.

   (c) Draw the circuit diagram of an Op-Amp based Instrumentation Amplifier using three Op-Amps and derive the expression for its differential voltage gain.

   (d) Define Signal-to-Noise Ratio (SNR) and Noise Figure (F). Calculate the overall noise figure of two cascaded amplifier stages.

   (e) Explain the function of the ALE (Address Latch Enable) pin and the five status flags in an 8085 microprocessor.

3. **Answer any two questions:** **[8 × 2 = 16]**

   (a) (i) Derive the expressions for characteristic impedance Z_0 and propagation constant γ of a symmetrical T-section network.

   (ii) Design a prototype constant-k low-pass filter (T and π sections) having a cut-off frequency f_c and nominal impedance R_0.

   (b) (i) Derive the total power relation in an Amplitude Modulated wave in terms of carrier power P_c and modulation index m, and calculate the transmission efficiency at $m = 1$.

   (ii) Explain the working principle of a Foster-Seeley discriminator circuit for FM demodulation with a neat circuit diagram.

   (c) (i) Derive the transmission line equations (telegrapher's equations) for voltage and current along a uniform two-wire transmission line.

   (ii) Explain the working principle and velocity modulation mechanism of a Reflex Klystron microwave oscillator.

PRACTICE QUESTION PAPER — SET 2

PHY-M-T-13: Electronics - II

Full Marks: 40 **Time: 2 Hours**

Answer all questions. The figures in the margin indicate full marks. Symbols have their usual meanings.

1. **Answer any four questions:** **[2 $\times$ 4 = 8]**

   (a) State the basic principle of operation of a Switched-Mode Power Supply (SMPS).

   (b) What is the intrinsic stand-off ratio (η) of a Unijunction Transistor (UJT)?

   (c) Differentiate between Vestigial Sideband (VSB) AM and Quadrature Amplitude Modulation (QAM) in television broadcasting.

   (d) What is a tri-state logic device? Mention its significance in microprocessor bus architecture.

   (e) Why cannot the TEM_{00} mode propagate inside a hollow single-conductor rectangular waveguide?

2. **Answer any four questions:** **[4 $\times$ 4 = 16]**

   (a) Explain how a Silicon Controlled Rectifier (SCR) is used for AC phase-angle power control, sketching the load voltage waveform.

   (b) Discuss the fabrication of monolithic integrated-circuit resistors and diffused capacitors in IC technology.

   (c) Draw and analyze a first-order RC active low-pass filter using an Op-Amp, deriving its transfer function and cut-off frequency.

   (d) Explain the working of a Successive Approximation Register (SAR) Analog-to-Digital Converter (ADC) with a block diagram.

   (e) Draw and explain the timing diagram for the Opcode Fetch machine cycle of an 8085 microprocessor.

3. **Answer any two questions:** **[8 $\times$ 2 = 16]**

   (a) (i) Explain the limitations of constant-k filters and show how an m-derived filter improves the attenuation characteristics near cut-off.

   (ii) Discuss thermal noise (Johnson-Nyquist noise) and shot noise in electronic circuits, deriving the expression for RMS thermal noise voltage across a resistor R.

   (b) (i) Explain the Armstrong indirect method of generating wideband Frequency Modulated (FM) signals using a block diagram.

   (ii) Establish the mathematical equivalence between Phase Modulation (PM) and Frequency Modulation (FM).

   (c) (i) Explain the principle of single-stub impedance matching on a high-frequency transmission line.

   (ii) Describe the construction, π-mode operation, and strapping technique of a cylindrical cavity Magnetron.

PRACTICE QUESTION PAPER — SET 3

PHY-M-T-13: Electronics - II

Full Marks: 40 **Time: 2 Hours**

Answer all questions. The figures in the margin indicate full marks. Symbols have their usual meanings.

1. **Answer any four questions:** **[2 × 4 = 8]**

   (a) What is an Insulated Gate Bipolar Transistor (IGBT)? Mention two of its advantages over a power MOSFET.

   (b) Why does an ideal Op-Amp differentiator suffer from high-frequency noise instability, and how is it overcome in a practical differentiator?

   (c) State Carson's rule for estimating the transmission bandwidth of an FM signal.

   (d) Distinguish between a flip-flop and a latch as binary storage elements.

   (e) Define cut-off wavelength λ_c and guide wavelength λ_g for a rectangular waveguide.

2. **Answer any four questions:** **[4 × 4 = 16]**

   (a) Explain the working principle of a DC-to-DC step-down (Buck) converter and derive the relation between duty cycle and output voltage.

   (b) Describe the fabrication steps of an enhancement-mode n-channel MOSFET in monolithic IC technology.

   (c) Draw the circuit of an Op-Amp logarithmic amplifier using a BJT in the feedback path and show that the output voltage is proportional to the logarithm of the input voltage.

   (d) Explain the operation of a Dual-Slope Integrating A/D Converter and state why it offers high noise immunity.

   (e) Explain the difference between absolute decoding and partial decoding in interfacing memory chips with an 8085 microprocessor, highlighting the issue of foldback memory.

3. **Answer any two questions:** **[8 × 2 = 16]**

   (a) (i) Explain the generation and detection of Double Sideband Suppressed Carrier (DSB-SC) signals using a balanced modulator and synchronous detector.

   (ii) Analyze an envelope detector circuit for standard AM demodulation and explain the causes of diagonal clipping and negative peak clipping.

   (b) (i) Discuss the frequency spectrum of a sinusoidal FM wave in terms of Bessel functions and explain the significance of carrier null points.

   (ii) Describe the reactance tube modulator method for direct FM generation.

   (c) (i) Write an 8085 assembly language program to find the largest number in an array of 10 bytes stored starting at memory location `2050H`, and explain the machine cycles involved.

   (ii) Discuss the TE and TM modes of wave propagation in a rectangular waveguide of dimensions $a \times b$ ($a > b$) and identify the dominant mode.

PRACTICE QUESTION PAPER — SET 4

PHY-M-T-13: Electronics - II

Full Marks: 40 **Time: 2 Hours**

Answer all questions. The figures in the margin indicate full marks. Symbols have their usual meanings.

1. **Answer any four questions:** **[2 × 4 = 8]**

   (a) Sketch the two-transistor analogy of a Silicon Controlled Rectifier (SCR) and write the expression for its anode current.

   (b) What is the primary advantage of CMOS logic gates in terms of static power dissipation?

   (c) Define characteristic impedance Z_0 of a lossless transmission line in terms of its distributed inductance L and capacitance C.

   (d) List the general-purpose registers and special-purpose 16-bit registers of an 8085 microprocessor.

   (e) Define directivity and coupling factor of a microwave directional coupler.

2. **Answer any four questions:** **[4 × 4 = 16]**

   (a) Design a practical Op-Amp integrator circuit and explain how the feedback resistor prevents output saturation due to input offset voltage.

   (b) Derive the characteristic impedance $Z_{0\pi}$ of a symmetrical π-section network and show that $Z_{0T}Z_{0\pi} = Z_1Z_2$.

   (c) Explain the working of a parallel comparator (flash) 3-bit A/D converter with a neat schematic and truth table.

   (d) Draw and explain the timing diagrams for the Memory Read and Memory Write machine cycles of an 8085 microprocessor.

   (e) Explain the working of a staggered-tuned FM discriminator circuit with its frequency response characteristics.

3. **Answer any two questions:** **[8 × 2 = 16]**

   (a) (i) Explain the architecture and working of a second-order Sallen-Key active high-pass filter and derive its voltage transfer function.

   (ii) Describe how an analog multiplier can be configured as an analog divider using an Op-Amp in the feedback loop.

   (b) (i) Compare DSB-FC, DSB-SC, and SSB-SC modulation schemes with respect to bandwidth requirement, power saving, and circuit complexity.

   (ii) Explain how a p-n junction varactor diode is used to generate Frequency Modulated waves.

   (c) (i) Discuss the travelling wave interpretation on a transmission line terminated by a complex load impedance Z_L, deriving the voltage reflection coefficient Γ.

   (ii) Explain the concept of resonant cavities in microwave engineering and determine the resonant frequency of a rectangular cavity resonator.