Khulna University of Engineering & Technology
B. Sc. Engineering 4th year 2nd Term (Regular) Examination, 2016
Department of Electrical and Electronic Engineering
EE 3219
Electrical Engineering Materials

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Define bravais lattice. "All crystal can be explained in terms of lattice and basis"-Justify the statement. (08)

(b) What do you understand by secondary bonding? Explain the hydrogen bonding. (08)

(c) Why we need to identify the crystallographic directions and planes? Explain point defects with their significance for determining the device performance. (10)

(d) The interaction energy between Na^+ and Cl^- ions in the NaCl crystal can be written as $E(r) = -\frac{4.03\times10^{-28}}{r} + \frac{6.97\times10^{-96}}{r^8}$, where the energy is given in joules per ion pair and inter ionic separation is in meters. Calculate the binding energy and the equilibrium ionic separation in the crystal; include the energy involved in electron transfer from Cl^- to Na^+. (09)

Q2. (a) Write down the assumptions of classical Drude model. (05)

(b) Why resistance appears in pure metal? Show that resistance of a pure metal is proportional to temperature. (11)

(c) Start from classical mechanics derive the relationship of conductivity and elucidate Ohm's law. (11)

(d) Briefly describe the Matthiensen's rule and Fourier's law of heat conduction. (08)

Q3. (a) Define drift mobility and relaxation time. Discuss the influence of carrier concentration and temperature on mobility. (10)

(b) "Large particles only manifest their particle nature, they never manifest their wave nature"-Justify the statement. (09)

(c) Solve the Schrödinger equation for a confined electron in a one dimensional infinite potential well. Show the possible energy wave functions, and the probability distribution for the electron. (16)

Q4. (a) Explain the physical meaning of E-K diagram. Describe the Fermi-Dirac statistics and explain the significance of Fermi energy. (11)

(b) What do you mean by effective mass and effective mass t**enson**? (06)

(c) Derive the relationship of electron energy density of states for a three dimensional solid. (09)

(d) Which properties of nonmaterials make them unique? State some peculiar applications of nanotechnology. (09)

Section B

Q5. (a) What do you mean by electric dipole moment and electronic polarization? Why electronic polarization within an atom is quite small compared with the polarization due to the valence electrons in the covalent bonds within the solid? (08)

(b) What is dielectric constant? Derive the Clausius-Mossoti equation and show that it allows the calculation of macroscopic properly from microscopic polarization phenomena. Also write the significance of the equation. (14)

(c) Briefly explain ionic and orientational polarization mechanism. (08)

(d) Draw the frequency dependence of the real and imaginary parts of the dielectric constant in the presence of **interferial**, orientational, ionic and electronic polarization mechanisms. (05)

Q6. (a) Derive the Debye equations. Also, draw the **cole-cole** plot and equivalent circuit of Debye dielectric. (10)

(b) Obtain the dielectric loss per unit capacitance in a capacitor in terms of the loss tangent. Obtain the phase difference between the current through the capacitor and that through R_p. What is the significant of δ? (09)

(c) Briefly discuss the major mechanisms that can lead to dielectric breakdown in solids. (08)

(d) Draw the bar-chart diagrams of some typical examples of dielectrics for a range of capacitance values and for a range of usable frequencies. (08)

Q7. (a) Briefly explain piezoelectricity, Ferro electricity and pyroelectricity. What do you mean by piezoelectric coefficient? (10)

(b) Briefly describe the construction of multilayer ceramic capacitor with diagram. (08)

(c) Explain the magnetization process using elementary current loops. (10)

(d) A toroidal coil with a ferrite core of 300 turns is used in HF work with small signals. The mean diameter of the toroid is 2.5 cm and the core is 0.5 cm. If the core is Mn-Zn ferrite. What is the approximate inductance of the coil? (07)

Q8. (a) Define magnetic domain, magnetocrystalline anisotropy and domain walls with necessary diagrams. (09)

(b) What do you mean by superconductor? Discuss the salient features of superconductivity. (14)

(c) A super conducting solenoid of 10 cm in diameter, 1 m in length and has 500 turns of Nb_3Sn wire, whose critical field B_c at 4.2 k is about 20 T and critical current density J_c is 3×10^6 Acm^{-2}. What is the current necessary to set up a field of 5 T at the center of a solenoid? What is approximate energy stored in the solenoid? Assume that the critical current density decreases linearly with the applied …. and the field across the diameter of the solenoid is approximately uniform. (12)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th year 2nd Term (Regular) Examination, 2016
Department of Electrical and Electronic Engineering
EE 4203
Switchgear and Protection

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) What do you mean by switchgear, controlgear and isolator? Mention the basic functions of circuit breaker. (08)

(b) What do you mean by auto-reclosure? Explain the dead time of auto-reclosure. (08)

(c) Discuss the problems that might arise during switching of a capacitor bank. Use relevant diagram in your illustration. (10)

(d) Define interlocking. Explain different types of interlocking with applications. (09)

Q2. (a) State the theories, postulates to explain the arc extinction phenomena. What are the significances of restriking voltages in arc extinction process? (13)

(b) What is resistance switching and why is it required? Show that the magnitude of opening resistance is inversely proportional to the fault current. (13)

(c) In a 132 kV power system, the circuit phase to ground capacitance is 0.02 μF, the inductance is 5 H. Calculate the voltage appearing across the pole of a CB if a magnetizing current of 8 A is interrupted instantaneously. Also calculate the value of pre-insertion resistor to be used across the contact space. (09)

Q3. (a) Mention the technical particulars of a CB. (06)

(b) Explain the operation of SF_6 circuit breaker. What sorts of maintenance are required for SF_6 circuit breaker? (11)

(c) Mention the names of some commercially available fuses. Explain ordinary fuse law. Give a comparison between fuse and circuit breaker. (08)

(d) In a short circuit test on a 130 kV, 3-Φ system the breaker gave the following data: p.f. of the fault is 0.45, recovery voltage is 0.95 times of full line voltage, breaker current is symmetrical and restriking transient has a natural frequency of 16 kHz. Determine the average RRRV. Assume the fault is grounded. (10)

Q4. (a) Which type of bus arrangement is suitable in respect of technically as well as economically? Draw and discuss. (08)

(b) What is relay co-ordination? Why is it important to have relay co-ordination? (07)

(c) Evaluate the settings and actual operating time of the following system used for over current protection. (20)

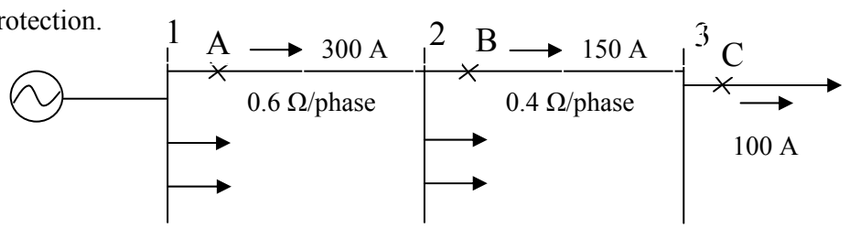


Fig. for Q4(c).

Section B

Q5. (a) What is fault? Fault cannot be avoided but can be minimized to some extent - Justify the statement. (08)

(b) Classify relays according to time of operation. (04)

(c) Attracted armature type relay cannot be used for distance protection. Explain with the help of torque equation. (08)

(d) Explain sensitivity, reliability and fault clearing time. (09)

(e) What is backup protection? Explain centrally co-ordinated backup protection. (06)

Q6. (a) Explain the principle of Merz-Price system of protection used for power X-former. Mention the limitation of this scheme and how are the overcome. (11)

(b) Explain the problems of blocking carrier scheme for the protection of X-mission line. (08)

(c) Explain the difficulties in busbar protection. (05)

(d) The following figure shows a protection of power system in a single line diagram. Calculate the time of operation of relays R_1 and R_2 for a fault immediately after relaying point R_2. Relay R_1 is voltage monitored overcurrent relay, the PS of which is 40% of the set value if the voltage collapses below 70% of rated voltage. (11)

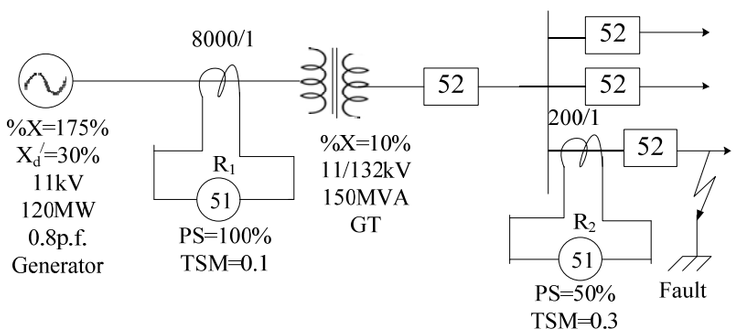


Fig. for Q6(d).

Q7. (a) Draw and explain the construction and working principle of Buchholz relay with relative advantages and disadvantages. (12)

(b) What are the various types of faults occur in a generator? Explain the operation of unrestricted earth fault protection scheme. (11)

(c) A line section has an impedance of (2.8+j5) Ω. Show this on R-X diagram as impedance vector. If the relay is adjusted to operate for a zero impedance short circuit at the end of the line section. Show on the same R-X diagram the characteristics of reactance and Mho relay. Assume that centre of Mho relay lies on an impedance vector. If the arcing fault occurs with an impedance of (1.5+j0) Ω anywhere along the line, find for each type of distance relay the maximum portion of the line that can be protected. (12)

Q8. (a) Explain the advantages of digital relay. (06)

(b) Why fault level at bus-bar is very high? Discuss the importance of bus-bar protection. (08)

(c) What is lightning? Describe the mechanism of lighting. Explain the working principle of valve type arrester. (11)

(d) An 11 kV, three phase, 30 MVA, star connected alternator is protected by an earth-fault relay having 10% setting. If the neutral resistance limits the maximum earth-fault current to 40% of full load value, determine the value of the resistor and percentage of the winding protected. Find also the value of earth resistor needed to allow only 9.5% of the winding to be left unprotected. CT ratio is 2000/1 A. (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2016
Department of Electrical and Electronic Engineering
EE 4205
RADAR, Satellite and Optical Communication

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.

(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) What is optical fiber? Show its typical configuration with necessary diagram. Define the terms: critical angle, phase velocity, and group velocity. Generally show different ray propagation techniques in fiber-optic waveguide. (12)

(b) Describe different loss mechanisms in silica optical fiber. (10)

(c) A typical relative refractive index difference for an optical fiber designed for long distance transmission is 1.5%. Estimate the NA and the solid acceptance angle for the fiber when the core index is 1.5. Further, calculate the critical angle at the core-cladding interface within the fiber. Assume that the concepts of geometric optics hold for the fiber. (13)

Q2. (a) Describe different types of dispersion in optical fiber waveguide. Why modal dispersion severely degrades system performance? Show that modal dispersion can be expressed by $\sigma_{mod} = \frac{N_{g1}}{cn_2}\delta n$. (13)

(b) A glass fiber exhibits material dispersion given by $|\lambda^2(d^2n_1)/d\lambda^2|$ of 0.025. Determine the material dispersion parameter at a wavelength of 1550 nm, and estimate the rms pulse broadening per kilometer for a good LED source with an rms spectral width of 20 nm at this wavelength. (11)

(c) Starting with Maxwell's equations, derive the eigenvalue equation by matching the boundary conditions at the core-cladding interface of a step-index fiber. (11)

Q3. (a) What are the important factors to be considered for making a suitable joint between two fibers? What is meant by Fresnel reflection? Classify different fiber couplers. (08)

(b) Classify different optical amplifiers. Draw the gain bandwidth characteristics of different optical amplifiers. (06)

(c) What is photodetector? Define the terms: Absorption coefficient, quantum efficiency, and responsivity. Show that the responsivity of P-I-N photodetector is $R = \frac{\eta e\lambda}{hc}$ where the symbols have their usual meanings. (12)

(d) An InGaAsP LED, with a band-gap of 1.5×10^{-19} J, is used as the transmitter for an optical system. The LED has a total quantum efficiency (given by the product of internal and external quantum efficiency) of 0.1. The diode current is 30 mA. (i) Estimate the wavelength of the optical output. (ii) Find the optical output power. (09)

Q4. (a) What is LASER? Draw the basic structure of Laser. Describe the working principle of DFB Laser. (12)

(b) Define fiber splicing. Discuss fusion splicing technique with necessary diagrams. (10)

(c) Draw the basic structure of an optical receiver. What are the sources of noise in an optical receiver? (05)

(d) A photodetector has a quantum efficiency of 65% when photons of energy 1.5×10^{-12} J are incident on it. Determine its operating wavelength. Also calculate the incident optical power required to obtain a photo current of 2.5 μA when the PD is operating as described above. (08)

Section B

Q5. (a) Draw the general structure of a satellite communication system and explain it in details. (07)

(b) What are the frequency bands used for satellite communication? Why is 6/4 GHz band popular? (08)

(c) Explain the terms: (i) System noise temperature, (ii) C/N ratio, (iii) EIRP, and (iv) G/T ratio. (08)

(d) A satellite at a distance of 40,000 km from a point on the earth's surface radiates a power of 2 W from the antenna with a gain of 17 dB in the direction of observer. Find the flux density at the receiving point and the power received by an antenna with an effective area of 10 m^2. (12)

Q6. (a) Define uplink design and show that the overall link design depends on the quality of downlink. (10)

(b) Describe different satellite multiple access formats in details. (12)

(c) What do you mean by Apogee and Perigee? (05)

(d) For the uplink of 4/6 GHz satellite system the frequency actually used is 6.175 GHz. Calculate the path loss. Assume diameter of earth station antenna and satellite antenna as 30 m and 1.5 m, respectively. (08)

Q7. (a) What are meant by active and passive satellites? (05)

(b) Describe the subsystems of a satellite earth station in brief. What is a small earth station? (13)

(c) Write short notes on LEO, MEO, and GEO. (09)

(d) For a satellite earth station receiver working on 4 GHz, the typical various gains and noise temperatures are T_{in} = 50 K, T_{RF} = 50 K, T_m = 500 K, T_{IF} = 1000 K, G_{RF} = 23 dB, G_m = 0 dB, G_{IF} = 30 dB. Calculate the system noise temperature. (08)

Q8. (a) What is radar? Describe the application of radar. What do you understand by continuous wave radar and pulse radar? (10)

(b) Draw the block diagram of MTI radar system and explain the functions of each block in brief. (10)

(c) Write short notes on LORAN, SONAR, and Radar beacons. (10)

(d) Explain the function of a duplexer in a radar system. (05)

Khulna University of Engineering & Technology

B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2016

Department of Electrical and Electronic Engineering

EE 4209

Semiconductor Device Theory

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.

(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Define Wigner-Seitz cell. "Hexagonal lattice never forms the bravais lattice" – Justify the statement. (07)

(b) What do you understand by Reciprocal lattice and Brillouin zone? Draw and calculate the Reciprocal lattice and Brillouin zone for graphene structure. (14)

(c) Sketch the energy spectrum of carbon from atom to its solid state form. What does the physical significance of hamiltonian of Schrodinger equation? How can Schrodinger equation be solved numerically? (14)

Q2. (a) Explain bloch theorem. (05)

(b) What is the basic concept of tight binding model? Determine the energy band diagram for Pi electron of graphene using tight binding model. (25)

(c) Mention various types of scattering that occur in semiconductor devices. What are their effects on device performances? (05)

Q3. (a) What do you mean by acoustic and optical phonon? Which phonons have the highest energy and why? (08)

(b) How the phonon dispersion relation can be calculated for diatomic semiconductor? Explain your answer. (16)

(c) Why various types of transport models are essential to explain semiconductor device physics? Explain the self consistent model for semiconductor homo devices. (11)

Q4. (a) What are the limitations of BJT? How these shortcomings are solved using HBT? Explain your answer. (09)

(b) What are the bases of drift diffusion model? Briefly explain the drift diffusion theory to describe carrier transport of semiconductor devices. (16)

(c) "Conductance in Ballistic devices are quantized and its value is, $G = \frac{2e^2}{\mathrm{h}}$" – Justify the statement. (10)

Section B

Q5. (a) Describe different semiconductor junctions with their application. (10)

(b) Draw the ideal energy-band diagram of a metal-semiconductor junction under forward and reverse bias. (08)

(c) What are the differences between pn junction diode and Schottky diode? (06)

(d) Derive the following metal-semiconductor work function difference equation for a MO System with necessary diagram. (11)

$$\phi_{ms} = \left[\phi'_m - \left(\chi' + \frac{E_g}{2e} + \phi_{fp}\right)\right]$$

Where the symbols have their usual meanings.

Q6. (a) Draw a typical structure of MOSFET. Derive the following ideal current-voltage relation for the n-channel MOSFET in the nonsaturation region. (17)

$$I_D = \frac{W\mu_n C_{OX}}{2L}[2(V_{GS} - V_T)V_{DS} - V_{DS}^2]$$

Where the symbols have their usual meanings.

(b) Draw the family of ideal I_D versus V_{DS} curves for an n-channel MOSFET in the enhancement mode and depletion mode. (08)

(c) What is meant by flat band condition? Derive the relation for gate bias necessary to generate flat band. Also draw the band diagram for that condition with biasing voltage. (10)

Q7. (a) Why C–V characteristics are important in MOS devices? Explain the ideal low frequency C–V characteristics of a MOS capacitor with p-type substrate. Also show the individual capacitance components. (10)

(b) Define heterojunctions of semiconductor. Classify heterojunction according to relative band position of two materials forming the junction. State and explain electron affinity rule. (10)

(c) Draw the band diagram of nP, nN, Np and pP heterojunctions. In which heterojunction will you get 2DEG? (15)

Q8. (a) Why heterojunction field effect transistor is a promising next generation devices. (08)

(b) Derive the following sheet carrier density equation of a δ-doped MODFET. (17)

$$n_s(V_G) = \frac{eN_d^+ d\delta + \epsilon\left[V_G - \left(\phi_b - \Delta E_c/e\right)\right]}{eD}$$

Where the symbols have their usual meanings.

(c) What are the limitations of single gate FET? How such limitations can be overcome using double gate FET and FinFET? (10)

Khulna University of Engineering & Technology

B. Sc. Engineering 4th year 2nd Term (Regular) Examination, 2016

Department of Electrical and Electronic Engineering

EE 4211

Microwave Engineering

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.
(iii) Smith chart may be provided on request.

Section A

Q1. (a) "A transmission line can be represented by an equivalent electrical circuit." – Justify the statement. (10)

(b) Derive the general expression of input impedance of a transmission line. How can it be used as resonators? – Explain. (15)

(c) A lossless transmission line having characteristics impedance of 600 Ω is terminated by a resistance of 100 Ω. Calculate the voltage standing wave ratio in the line. (10)

Q2. (a) How can you use a $\lambda/4$ T-line as matching network? Show a matched feed network of a 2×1 MPA array with the help of $\lambda/4$ T-line. (14)

(b) Define VSWR and reflection co-efficient. Derive the relationship between them. What are RL and IL? (13)

(c) A transmission line has characteristic impedance of 600 Ω and it is terminated with a resistive load of 900 Ω. Give an arrangement of single stub matching. (08)

Q3. (a) Define the following antenna terminologies: (12)
(i) Solid angle (ii) gain (iii) directivity (iv) null (v) effective height and (vi) radiation intensity.

(b) Describe different types of antenna apertures. (15)

(c) Let's say, you have source with sine (doughnut) power pattern. Calculate the directivity. (08)

Q4. (a) In case of two isotropic point sources of same amplitude but opposite phase, deduce the expression of resultant field and draw the field pattern. (10)

(b) "Log periodic antenna provides frequency independency." – Justify the statement. (12)

(c) Describe the working principle of Yogi-Uda antenna with neat sketch. (13)

Section B

Q5. (a) Why Smith chart is called "magical tool" for solving transmission line problems? – Explain. For the transmission line shown in Fig. Q5(a), (20)

(i) Find the distance of 2nd V_{max} from the load.

(ii) What is the value of line impedance at 5 cm from the load?

(iii) If a short-circuited stub of characteristics impedance 30 Ω is required to match the load, determine the length (l) of the stub and the stub position (d) from the load.

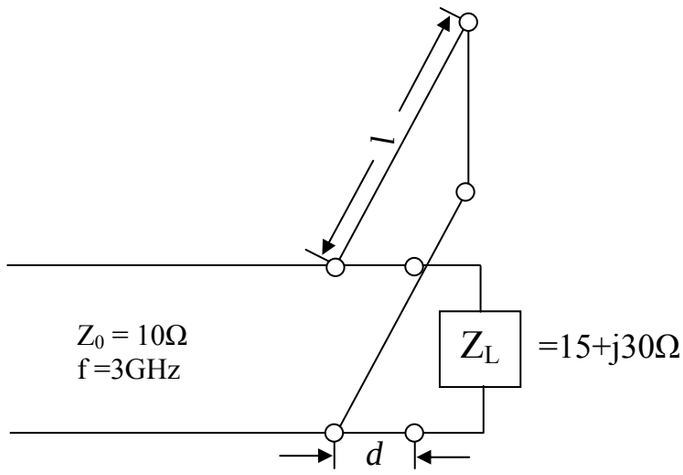


Fig. for Q5(a).

(b) Define waveguide. What are TE, TM and TEM mode? For infinitely extent parallel plate find the solutions of TE mode. (15)

Q6. (a) What is the basic difference between O-type and M-type tubes? (05)

(b) "The limitations of conventional vacuum tubes made them to be replaced by present day microwave tubes such as O-type and M-type tubes" – What are these limitations? Explain the "Transit time effects" in diodes (large signal condition) with appropriate graphical representation. (15)

(c) A two-cavity Klystron amplifier has the following parameters: (15)

Beam Voltage: $V_0 = 900$ V, Beam Current: $I_0 = 30$ mA

Frequency: f = 8 GHz, Gap Spacing in either cavity: d = 1 mm

Spacing between centres of cavities: L = 4 cm

Effective shunt impedance: $R_{sh} = 40$ kΩ

Determine:

(i) The electron velocity, (ii) The dc electron transit time

(iii) The input voltage for maximum output voltage and (iv) The voltage gain in dB.

Q7. (a) Mention differences between Klystron and TWT. (05)

(b) Explain the operation of four-cavity Klystron amplifier with neat sketch. (15)

(c) Draw the simplified circuit diagram of a TWT and describe its amplification process. (15)

Q8. (a) "A reflex Klystron is commonly used as oscillator" – How this oscillation occurs? Explain with proper schematic diagrams. (11)

(b) Deduce the equation of the Hull cut off voltage equation in case of magnetron operation. (12)

(c) An X-band pulsed cylindrical magnetron has the following operating parameters: (12)

Anode voltage	:	$V_0 = 26$ kV
Beam current	:	$I_0 = 27$ A
Magnetic flux density	:	$B_0 = 0.336$ Wb/m^2
Radius of cathode cylinder	:	a = 5 cm
Radius of vane edge to center:		b =10 cm

Compute:

(i) The cyclotron angular frequency

(ii) The cut-off voltage for a fixed B_0

(iii) The cut-off magnetic flux density for a fixed V_0.

Khulna University of Engineering & Technology
B. Sc. Engineering 4th year 2nd Term (Regular) Examination, 2016
Department of Electrical and Electronic Engineering
EE 4217
Power Plant Engineering

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.
(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Define power plant. What types of power plants are suitable to cater the base load and peak load? Give reasons in favour of your answer. (10)

(b) Show the main parts of a power station mentioning their design criteria. (05)

(c) What are the factors to be considered for selecting the type and location of a generating station? (10)

(d) The annual peak load on a 30 MW power station is 25 MW. The power station supplies loads having maximum demands of 8.5 MW, 10 MW, 5 MW and 4.5 MW. The annual load factor is 45%. Find the (i) average load, (ii) energy supplied per year, (iii) diversity factor and (iv) demand factor. (10)

Q2. (a) What is load curve and load factor? Explain how load curve help in selection of size and number of generating station. (09)

(b) What is depreciation? Discuss the sinking fund method for determining depreciation. (08)

(c) What are the desirable characteristics of tariff? Enlist the names of different types of tariff? (10)

(d) A power station has a maximum demand of 15000 kW. The annual load factor is 50% and plant capacity factor is 40%. Determine the reserve capacity of the plant. (08)

Q3. (a) What is a sub-station? Discuss different types of bus-bar arrangements used in sub-stations with a suitable diagram. (11)

(b) Draw the key diagram of a typical 66/11 kV substation. Both 66 kV and 11 kV have single circuit and single bus bar but the 66 kV bus bar is sectionalized. (12)

(c) Incremental fuel cost in dollar per megawatthour for a plant consisting of two units are given by (12)

$$\frac{dF_1}{dP_1} = 0.0080P_1 + 8.0 \text{ and } \frac{dF_2}{dP_2} = 0.0096P_2 + 6.4$$

Q4. (a) What is failure rate? Discuss different regions of bathtub curve. (08)

(b) "All components that are still working in useful life are equally reliable and can be treated equally regardless of their in-service date." – Justify the statement. (08)

(c) What is MTTF? Determine the reliability of a system comprising of two identical components connected in parallel. Both components have equal reliability given by $R(t) = e^{-\lambda t}$. Also determine the MTTF of the system. (11)

(d) Three spare transformers supporting 100 single-bank stations. If the failure rate of a transformer in service is 0.1 per year, what is the probability of having no spares available in a year? (08)

Section B

Q5. (a) Define binding energy and mass defect. "Higher the binding energy per nucleon, higher is the stability of the nucleus" – Justify the statement with an example. (10)

(b) Why the neutron is used as bombardment particle in a chain reaction? Discuss different methods of producing neutrons. (10)

(c) What do you mean by elastic and inelastic scattering? Derive an expression of mean free path in terms of macroscopic cross section. (10)

(d) A nuclear reactor uses U^{235} as fuel. If the mass of fuel is 1.2 kg and neutron flux is 10^{16} per sec, calculate the power of the reactor. (05)

Q6. (a) Draw and explain the essential parts of a steam power plant. (10)

(b) What is penstock in a hydro-electric power plant? What factors should be taken into account while selecting the site for a hydro-electric power station? (08)

(c) Briefly describe how a geothermal power plant works. (05)

(d) Why do we need hybrid power system? Explain the problems associated with the variability of solar photovoltaic system's output integrated with a diesel power plant. How can you solve these problems? (12)

Q7. (a) Define moderating power and moderating ratio. Why a fast breeder reactor does not require any moderator? (08)

(b) What are the basic factors to be considered during the design of a nuclear reactor? Describe the principle of operation of a boiling water reactor. (10)

(c) What are the requirements of a PV module installation recommended by IDCOL in Bangladesh? (07)

(d) A steam power station spends Tk 40,00,000 per annum for coal used in the station. The coal has a calorific value of 5000 kcal/kg and costs Tk 600 per ton. If the station has a thermal efficiency of 33% and electrical efficiency of 90%, find the average load on the station. (10)

Q8. (a) What is tidal power? Describe the operation of a single basin one tidal power plant. (07)

(b) Show that the available wind power per unit area is directly proportional to the average of the wind speed cubed. (10)

(c) What are the different methods for producing energy from biomass? Explain the working principle of a magneto hydro-dynamic power plant. (10)

(d) Why do we need energy storage? Briefly explain how a battery works? (08)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2016
Department of Electrical and Electronic Engineering
EE 4235
Digital Image Processing

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.

(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) What do you mean by digital image processing? Explain the fundamental steps in digital image processing. (11)

(b) Explain the image formation technique clearly. Also write down the main problem during image acquizition. (10)

(c) Write down the properties of Hadamard transform. Consider the image (U) and transform (A) as follows: (14)

$$U = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \text{ and } A = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}.$$

What is the transformed output? And also find the basis image.

Q2. (a) Show that the 2D discrete Fourier transform and its inverse are periodic functions. Mention the dc and ac value of the transform. (10)

(b) Explain the seperability properties of DFT formula. What is its advantages? Prove that $F(u, v) = F^*(-u, -v)$, where the symbols have their usual meanings. (10)

(c) For $N = 8$, draw the waveforms of cosine basis function. Assume 1D DCT. (15)

Q3. (a) Write down the following operations mathematically. Assume image resolution in M×N. (15)
(i) Compute per element sum of two arrays A_{ij} and B_{ij}, (ii) Compute per element difference between two arrays A_{ij} and B_{ij}, (iii) Compute per element product of two arrays A_{ij} and B_{ij}, (iv) Perform per element division of array A_{ij} and B_{ij}, (v) Transpose of an image A_{ij}, (vi) Flip an image A_{ij} horizontally, (vii) Flip an image A_{ij} vertically, (viii) Calculate average array elements of B_{ij}, (ix) Return trace of an array A_{ij}, (x) Calculate absolute difference between two arrays C_{ij} and D_{ij}.

(b) For the following image A: (12)

$$A = \begin{bmatrix} 2 & 10 & 20 \\ 20 & 100 & 255 \\ 254 & 20 & 210 \end{bmatrix}$$

Find (i) average, (ii) standard deviation, (iii) coefficient of variation, (iv) mode, (v) signal-to-noise ratio, and (vi) median.

(c) Explain the following geometrical operations of an image: (08)

(i) Scaling, (ii) Rotation, (iii) Translation, and (iv) affine transform.

Q4. (a) What are the different color space models? Mention their classifications with applications. (08)

(b) Assume a pixel has the following RGB values: (12)

R = 205, G = 113, B = 81. What are the corresponding Y, C_b, C_r values? what are the corresponding H, S, L values, and H, S, V values?

(c) The input image and the kernel are given below. Find the convoluted output image at position (0,0), (1,1), and (2,2). Use 2D convolation. (15)

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \qquad \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

input kernel

Section B

Q5. (a) What do you mean by histogram and histogram equalization? Write down the application of color look up table. (08)

(b) Explain different types of images with examples. Also calculate the file size of different kind of images in Kbyte. (11)

(c) Use the following 2×2 8 bit gray-level image as the input for this problem: (08)

$$\begin{bmatrix} 200 & 250 \\ 100 & 50 \end{bmatrix}$$

Determine the resulting monochrome image if the dither matrix is as

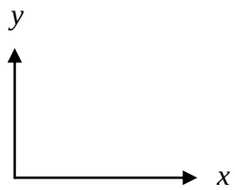
$$\begin{bmatrix} 0 & 8 & 2 & 10 \\ 12 & 4 & 14 & 6 \\ 3 & 11 & 1 & 9 \\ 15 & 7 & 13 & 5 \end{bmatrix}.$$

(d) Write an equation for saturate salt and pepper noise. A saturated salt and pepper noise has L = 0.975. The average gray level of an image without noise is 100. Estimate the mean and variance of the noise. (08)

Q6. (a) What do you mean by edge? Mention the causes of edge. What are the performance indicators of edge detector. (09)

(b) What do you mean by threshold value? Consider the following sub-image (12)

0	0	50	50	50	
0	0	50	50	50	
0	0	50	50	50	
0	0	0	0	0	
0	0	0	0	0	



Consider a 3×3 neighborhood. Using backward difference, compute the two eigen values λ_1 and λ_2 for a corner detector. If the threshold is 3000, will it be considered as a corner?

(c) Consider the following sub-image: (14)

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 72 & 72 & 0 \\ 0 & 0 & 36 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Use the centre difference method, calculate the edge strength and edge normal at the centre pixel using canny edge detector. Assume any 1-D Gaussian mask if required.

Q7. (a) What do you mean by a non-linear filter? Compare the performance of the Gaussian and median filter. What filter do you think would be effective to remove noise and why? (09)

(b) Let us consider the string as "ENGINEERING" and we would like to individually encode each character. (i) Construct the Huffman coding tree, (ii) Show the Huffman code table, (iii) What is the resulting code for the given string? and (iv) What is the entropy of this string. (12)

(c) In this problem, we will use the following dictionary (or string table) (14)

Code	String
1	C
2	D
3	E
4	F
5	G

(i) What are the output codes if the input to the LZW encoder is CEFGCEFGECEF

(ii) What is the output string if the input codes to the LZW decoder are 162379.

Q8. (a) What do you mean by chroma sub-sampling? Show the scheme 4:4:4, 4:2:2, 4:1:1 and 4:2:0 used in image and video coding research. (08)

(b) Explain why compression is required. Draw the block diagram of encoder and show the major steps in JPEG compression. (08)

(c) For the following two local patches: (06)

$$\begin{matrix}15 & 15 & 30\\ 10 & 10 & 20\\ 40 & 20 & 20\end{matrix} \quad \text{and} \quad \begin{matrix}15 & 35 & 50\\ 30 & 35 & 25\\ 40 & 20 & 20\end{matrix}$$

Calculate (i) normalized cross correlation (NC), (ii) SSD, and (iii) SAD.

(d) Let us simplify the hierarchical JPEG by considering only 2 layers as follows: (13)

Assume that the input is a 4×4 image as

$$f = \begin{bmatrix} 11 & 55 & 88 & 22\\ 44 & 22 & 33 & 77\\ 66 & 55 & 109 & 79\\ 88 & 99 & 89 & 119\end{bmatrix}$$

and the quantization matrices for Encoder 1/Decoder 1 and Encoder 2/Decoder 2 are as follows:

Quantization matrix for Encoder 2/Decoder 2 is $\begin{bmatrix}10 & 10\\ 10 & 10\end{bmatrix}$ and Quantization matrix for Encoder 1/Decoder 1 is $\begin{bmatrix}5 & 5\\ 5 & 5\end{bmatrix}$.

(i) Determine the value of the following expression: $f_2, F_2, \tilde{f}_2, E(\tilde{f}), d_1, D_1, \widetilde{d_1}$, and $\tilde{f}$.

(ii) What is the MSE between the original image f and the reconstructed image $\tilde{f}$?

(iii) What is the resulting reconstructed image $\tilde{f}$?

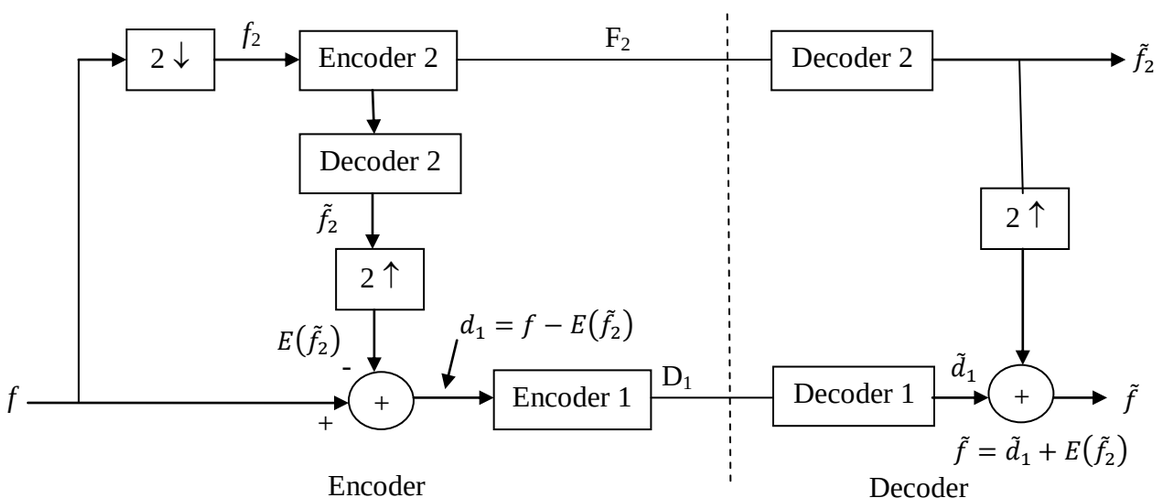


Figure for Q. 8(d)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2016
Department of Electrical and Electronic Engineering
EE 4237
Special Machines and AC Drives

Time: 3 hours Full Marks: 210

N.B.: (i) Answer **ANY THREE** questions from each section in separate scripts.

(ii) Figures in the right margin indicate full marks.

Section A

Q1. (a) Show that a dc series motor can operate with ac supply. Compare the performance with ac and dc supply. Describe the technique to improve the motor performance. (12)

(b) Explain the repulsion start principle. Describe the operating principles of repulsion start induction motor and repulsion-induction motor. (13)

(c) A universal motor has a 2-pole armature and a back emf of 49.1 V. The motor operates at 5000 rpm and the armature current is 4.6 A; the armature terminal voltage is 100 V and the power taken is 300 W. The armature resistance is 3.5 Ω. Find the effective armature reactance and the useful flux. (10)

Q2. (a) What are servomotors? How do servomotors differ in application capabilities from large industrial motors? Explain the torque-speed characteristics of dc and ac servomotors. (10)

(b) Describe the rotor construction of stepper motor. Explain the operation of a variable reluctance 4-pole 3-phase servomotor with half stepping switching logic. (09)

(c) What is microstepping principle of stepper motors? Explain it. (08)

(d) A single-stack, 3-phase VR motor has a step angle of 15^o. Find the number of its rotor and stator poles. (08)

Q3. (a) Show that a hysteresis motor is a constant torque motor. Describe the construction of the motor. Show some applications of the motor. (13)

(b) Explain the construction and operating principle of a linear induction motor. (10)

(c) Describe the operating principle of a synchronous reluctance motor. How can you construct a reluctance motor from a squirrel cage induction motor in the laboratory? (12)

Q4. (a) Describe the operating principle of a rotating power amplifier. (08)

(b) What are the permanent magnet materials of importance constructed from rare-earth materials? Show the structure of a BLDC motor. Write down the equations of a BLDC motor. (10)

(c) Write down some applications of PMSM. What are the differences between the IPMSM and SPMSM? (10)

(d) Show the operating principle of an electrostatic motor. (07)

Section B

Q5. (a) Define energy and co-energy. Find the energy and mechanical force for a linear magnetic systems for which $\lambda = L(x)i$, where the symbols/variables have their usual meanings. (12)

(b) For a multiply excited rotating magnetic field system deduce the equation for field energy and torque. (13)

(c) A rotating electromechanical energy conversion system has the following inductances in terms of θ in radians (angle between rotor and stator axes): (10)

$L_{11} = 0.536\theta$, $L_{22} = -0.25+1.65\theta$, $L_{12} = L_{21} = -0.35+1.23\theta$.

Find the torque developed for $i_1 = 12$ A and $i_2 = -12$ A.

Q6. (a) What are the methods employed for speed control of induction motors? Describe any one of the control methods applicable to squirrel-cage induction motors. (09)

(b) Draw the block diagrams of VSI and CSI fed drives with dynamic breaking behaviour. (08)

(c) What is slip power? How is the speed control of a wound-rotor induction motor obtained by controlling the slip power? (08)

(d) Imagine you are a motor drive designer, and an industry asked you to design a speed controller for a slip-ring type induction motor using static Scherbius drive for half the rated motor torque and speed of 750 rpm. The specifications of the motor drive supplied by the industry are as follows: (10)

Specifications: 3-φ, 440 V, 970 rpm, 6-pole, Y-connected, $R_s = 0.1\Omega$, $R_r' = 0.08\Omega$, $X_s = 0.3\Omega$, $X_r' = 0.4\Omega$, stator to rotor turns ratio is 2, dc-link inductor resistance is 0.01 Ω, and transformer turns ratio is 8.

How will you select the firing angle of the drive mathematically for stable operation?

Q7. (a) Discuss the principles of vector control of induction motor. (08)

(b) What are the vectors of a polyphase induction motor? Compare the direct and indirect vector control methods. Describe the indirect vector control method of induction motors with the limitations. (15)

(c) A Y-connected squirrel-cage induction motor has the following ratings and parameters: (12)

400 V, 50 Hz, 4-pole, 1370 rpm, $R_s = 2\Omega$, $R_r' = 3\Omega$, $X_s = X_r' = 3.5\Omega$, $X_m = 55\Omega$.

The motor is controlled by a current source inverter at constant flux. Calculate motor torque, speed and stator current when operating at 30 Hz and rated slip speed.

Q8. (a) Draw a basic closed-loop control structure of synchronous motors. How does volts/hertz control work in constant-torque and constant-power regions in the torque-speed characteristics of synchronous motors. (12)

(b) Describe the load-commutated inverter (LCI) drive for a synchronous motor. How is the current-commutation provided in the LCI drive at low speeds? (14)

(c) Discuss the principles of operation of brushless DC and AC motor drives. (09)