Khulna University of Engineering & Technology
B. Sc. Engineering 4th year 2nd Term (Regular) Examination, 2018
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 is meant by switchgear and load break switch? Write down the advantages of using multi break switch over a single break switch. (09)

(b) Explain interlocking. How interlocking can be achieved in power system? Explain the function of auxiliary switch. (10)

(c) Explain the methods of increasing the arc resistance. (09)

(d) What are the causes of developing arc during opening the contacts of a CB? (07)

Q2. (a) Why bulk oil circuit breakers become obsolete today? Describe the construction and operating principle of SF6 circuit breaker with relevant advantages and disadvantages. (15)

(b) Clearly explain "frame earth protection" for the indoor bus bar. (08)

(c) The following figure shows a portion of power system in a single line diagram. Find out 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 reduces to 40% of the set value if voltage collapses below 70% of the rated voltages. (12)

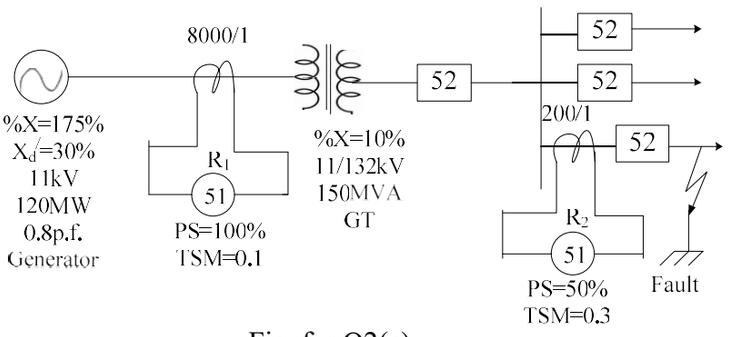


Fig. for Q2(c).

Q3. (a) What do you mean by short time rating of circuit breaker? Show the relation between making and breaking capacity of circuit breaker. (09)

(b) Explain the effect of frequency and power factor on TRV. (08)

(c) Explain Cassie's theory for arc interruption with assumptions. (08)

(d) Deduce the expression for ordinary fuse law. The melting point of lead fuse is 624°F. What will be the temperature of the fuse when 5/6 of the fusing current passes through it? The room temperature is 55°F. (10)

Q4. (a) Define fusing factor clearly. Mention the factors upon which fusing current depends on. Also, write down the disadvantages of HRC fuse. (09)

(b) Why resistance switching is required? Show that the magnitude of opening resistor is inversely proportional to the fault current. (11)

(c) What is current chopping? Illustrate the phenomena while interrupting capacitive current. (07)

(d) A 50 Hz, 3-Φ alternator has rated voltage 13.5 kV, connected to circuit breaker, inductive reactance 4 Ω/Φ, C=2 μF. Determine maximum RRRV, peak restriking voltage and frequency of oscillations. (08)

Section B

Q5. (a) What do you mean by relay co-ordination? Mention the various functions of protective relaying. (08)

(b) Why the protective zones are arranged in overlap fashion? Explain with diagram how the zones are overlapped. (08)

(c) How is the torque produced in induction type relays? Derive the torque equation with neat sketch. (12)

(d) "Fault cannot be avoided completely but can be minimized"—Justify the statement. (07)

Q6. (a) What is biased coil? Why it is used in differential protection? With the help of neat sketch, explain the percentage differential protection for a star/delta power transformer. (15)

(b) Write down the different bus bar layout. "One-and-a-half breaker bus arrangement is popular for high voltage sub-station." Explain. (08)

(c) Define earthing. Compare equipment earthing and neutral earthing for protection. (07)

(d) Write down the advantages and limitations of Buchholz relay. (05)

Q7. (a) What is lightning? How is it produced? Explain a lightning overvoltage protection scheme for transformer. (15)

(b) Write down the various types of fault occur in a generator. Explain the operation of a restricted earth fault protection with suitable diagram. (11)

(c) An 11 kV, three phase, 50 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 the earth resistor needed to allow only 9.5% of the winding to be left unprotected. CT ratio is 2000/1 A. (09)

Q8. (a) Describe the 3-zone protection for transmission line. Reactance type distance relay should satisfy two conditions for proper protection. Explain with torque equation. (15)

(b) Write down the advantages of digital relays. (06)

(c) Explain carrier current protection of transmission line. (06)

(d) Why fault level at bus bar is very high? Discuss the impedance of bus bar protection. (08)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2018
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? Develop two equations for numerical aperture that measure the light collecting ability of fiber. (11)

(b) Describe different loss mechanisms in silica optical fiber with necessary diagrams. (12)

(c) The relative refractive index difference between the core and cladding of an optical fiber is 0.70%. If the refractive index at the core is 1.45, estimate (12)

(i) The value of NA.

(ii) The critical angle at the core cladding interface.

(iii) The solid acceptance angle in the air.

Q2. (a) Starting with Maxwell's equations, derive the eigenvalue equation by matching the boundary conditions at the core-cladding interface of a step-index fiber. (14)

(b) What are the dispersion mechanisms found in fiber optic waveguide? Derive the mathematical expression for the material dispersion parameter. (11)

(c) A glass fiber exhibits material dispersion given by $|\lambda^2(dn_1)/d\lambda^2|$ 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. (10)

Q3. (a) What are different fiber joints? Show different types of fiber misalignments with necessary diagrams. Discuss fiber splicing technique with suitable illustrations. (10)

(b) Define population inversion condition in a laser medium. What do you understand by spontaneous and stimulated emission? Draw basic structure of a laser and then explain the operation of DFB laser. (11)

(c) Classify different fiber couplers. What is GRIN-rod lens? Describe its application in fiber optic communication. (08)

(d) An optical fiber has a core refractive index of 1.5. Two lengths of the fibers with smooth and perpendicular end faces are butted together. Assuming the fiber axes are perfectly aligned. Calculate the total optical loss in decibels at the joint due to Fresnel reflection when there is a small air gap between the fiber and faces. (06)

Q4. (a) What is photodetector? Classify different types of photodetectors. Show the typical structure of p-i-n and pn photodetector and then describe why the performance of p-i-n photodetector is better than pn photodetector. (10)

(b) Define the terms: Absorption coefficient, quantum efficiency, and responsivity. Show that the responsivity of p-i-n photodetector is $R = \frac{ne\lambda}{hc}$, where the symbols have their usual meanings. (10)

(c) Draw the basic structure of an optical receiver. What are the sources of noise in an optical receiver? (07)

(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? (09)

(c) Describe the technical particulars of Bangabandhu Satellite-1. How will it impact the satellite services in Bangladesh? (10)

(d) A satellite is rotating in an elliptical orbit with a perigee of 1000 km and an apogee of 4000 km. Calculate its orbital period. (09)

Q6. (a) Explain the terms: (i) EIRP, (ii) Faraday's effect, (iii) Doppler's effect, and (iv) FoM. (10)

(b) Mention communication satellite subsystems, their functions and parameters of importance in a tabular form. (10)

(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, and G_{IF} = 30 dB. Calculate the system noise temperature. (06)

Q7. (a) Draw the block diagram of satellite earth station and then explain function of each block. (10)

(b) Describe different satellite multiple access formats in details. (10)

(c) What do you mean by CW radar and pulse radar? Derive the following expression: (15)

$$r_{max} = \left[\frac{P_t A_0^2 S}{4\pi\lambda^2 k T_0 \delta_f (F-1)}\right]^{1/4},$$

where the symbols have their usual meanings.

Q8. (a) What is MTI? Draw the block diagram of MTI radar system and discuss the functions of each block in brief. (10)

(b) What is meant by maximum unambiguous range? Define false alarm rate and probability of detection (06)

(c) Write short notes on LORAN, Radar beacons, and ILS. (12)

(d) Explain the function of a duplexer in a Radar system. (07)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2018
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) Write down some physical processes that are caused by lattice vibrations. What are the basic differences between monoatomic and diatomic chain model vibrations? (07)

(b) Derive the frequency expression for diatomic chain model of vibration. From this expression, deduce the maximum value of the optical branch and minimum value of the acoustic branch. (15)

(c) What are the limitations of conventional BJTs? Which properties of HBTs help to overcome these limitations? (05)

(d) Consider the normal modes of a linear chain, in which the force constants between nearest-neighbor atoms are alternately 'c' and '10c'. Let the masses be equal, and let the nearest-neighbor separation be $a/2$. Find $\omega(k)$ at $k = 0$ and $k = \pi/a$. Also, sketch the dispersion relationship of this system. (08)

Q2. (a) What are the assumptions that are made for 1D tight binding model? From the formation of Hamiltonian matrix derive the dispersion relationship of the tight binding chain. (15)

(b) What is meant b Bandwidth (BW)? Why the BW increases when the atomic spacing is decreased? Explain it with the viewpoint of tight binding model. (10)

(c) Prove that the dispersion relation at the bottom of the band is parabolic in nature. Also, find out the effective mass of electron at the bottom of the band. (10)

Q3. (a) What do you mean by acoustic and optical phonon? Which phonons have the highest energy and why? (07)

(b) Why various types of transport models are essential to explain device physics? Derive the drift-diffusion model from Boltzmann transport model for current density. Also, write its limitations. (18)

(c) What are the different features shown by ballistic transport model? Derive the launder formula for ballistic conduction. (10)

Q4. (a) What is scattering? Briefly describe the different scattering mechanisms in semiconductors. Which scattering mechanism is the most sensitive to temperature? (10)

(b) Explain the step by step procedure for the calculation of energy band diagram and carrier density of a homo-junction structure by self-consistent quantum mechanical model. (15)

(c) What is the physical significance of Hamiltonian matrix in solving Schrodinger equation? (04)

(d) A proton is confined in an infinite square well of width 10 fm. Calculate the energy and photon emitted when the proton undergoes from the first excited state ($n = 2$) to the ground state ($n = 1$). (06)

Section B

Q5. (a) What are the basic building blocks of semi-conductor devices? Write down the characteristics and applications of these blocks. (07)

(b) Mention the basic differences between homo and hetero junctions. Determine the band diagram of (i) P-N homojunction (ii) M-S Schottky junction (iii) M-S ohomic contact at thermal equilibrium, forward and reverse bias conditions. (18)

(c) What is tunneling barrier? How it is formed? Determine the theoretical barrier height, built-in potential barrier, and maximum electric field in a metal-semiconductor diode for zero applied bias. Consider a contact between tungsten and n-type silicon doped to $N_d = 10^{16}$ cm^{-3} at T = 300 K. Here $\varphi_m = 4.55$ V and x = 4.01 V. (10)

Q6. (a) What is an image force effects on Schottky barrier lowering? Derive the equation of Schottky barrier lowering due to image force effects with proper schematics. (10)

(b) What are the different current transport process in metal-semiconductor hetero-junction? Describe the thermionic emission process for finding current density in Schottky junction. (15)

(c) Determine ΔE_C, ΔE_V, and V_{bi} for n-Ge to p-GaAs heterojunction using electron affinity rule. Consider n-type Ge doped with $N_d = 10^{16}$ cm^{-3} and p-type GaAs doped with $N_a = 10^{16}$ cm^{-3}. Let T = 300 K, so that $n_i = 2.4\times10^{13}$ cm^{-3} for Ge. Here, $x_n = 4.13$ V, $x_p = 4.07$ V and $\Delta E_g = 0.76$ V. (10)

Q7. (a) Why HEFT is preferable than MESFET/MOSFET? Write down the advantages of HFET. (10)

(b) Describe the charge control model of Delta doped HFET with proper diagram and equations. Also, find out the thickness of 2DEG. (15)

(c) What is meant by scaling and technology node? Write down the effect of scaling or short channel. (10)

Q8. (a) Write down the voltage ranges and corresponding modes of MOS capacitor. Draw the energy band diagram and charge density diagram of these modes using p-type substrate. (12)

(b) What is a C-V characteristics? Write the equations of capacitance of three modes of MOS and draw the C-V curve using p-type substrate both for low and high frequencies. (13)

(c) Mention the effects and solutions of short channel scaling. Write short notes on (i) planar MOSFET and FinFET (ii) prons and cons of SOI-FET. (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2018
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) Define the following antenna terminology: (15)
(i) Gain (ii) Beam area (iii) FBR (iv) Radiation intensity (v) Main lobe.

(b) Mention different apertures related to antenna. Deduce the expression of maximum effective aperture. (10)

(c) Derive the Friss transmission formula. (10)

Q2. (a) What is an isotropic radiator? Show that the Poynting vector varies inversely as the square of the distance from a point source radiator. (12)

(b) Calculate the directivity for the sources with (i) unidirectional cosine-squared power pattern (ii) sine power pattern. (09)

(c) Write short notes on any two: (i) Rhombic antenna (ii) V-antenna (iii) Yagi-Uda antenna. (14)

Q3. (a) Derive the exponential form of voltage and current equation along the transmission line, and hence deduce the expression of input impedance of a infinity transmission line. How do you relate it with characteristic impedance of a T-line?—Explain. (20)

(b) Define RL, IL, and VSWR of a microwave system. Calculate the input impedance of a 25 cm transmission line having characteristic impedance of 600 Ω and the line is terminated by a reactance of $j150$ Ω. The frequency of operation is 300 MHz. (15)

Q4. (a) "A transmission line can be represented by an equivalent electrical circuit"—Justify the statement. (10)

(b) In what condition, you can use a transmission line as a series resonator?—Explain. (10)

(c) Calculate the length and position of a stub that would enable the main length of the line to be correctly terminated at a frequency of 150 MHz. The RF transmission line has a characteristic impedance of 600 Ω and is connected to a resistive load of 75 Ω. (15)

Section B

Q5. (a) "Waveguide acts as a high-pass filter"—Put justification on your answer. (11)

(b) Define waveguide. For the rectangular waveguide derive the solution to the Helmholtz equation in rectangular coordinates. What are TE and TM modes? (16)

(c) A TE_{11} mode is propagating through a circular waveguide. The radius of the guide is 10 cm, and the guide contains an air dielectric. (08)
Determine:
(i) the cutoff frequency.
(ii) the wavelength for an operating frequency of 3 GHz.

Q6. (a) Explain transit time effect. Also discuss the process of electron current generation in triodes with neat sketch. (13)

(b) Explain the working principle of a 2-cavity Klystron amplifier. (12)

(c) A two-cavity Klystron amplifier has the following parameters: (10)

V_0 = 1200 V, R_0 = 50 kΩ

I_0 = 25 mA, f = 3 GHz,

Gap Spacing in either cavity: d = 1 mm

Spacing between centres of cavities: L = 5 cm

Effective shunt impedance: R_{sh} = 30 kΩ

(i) Find the input gap voltage to give maximum voltage V_2.

(ii) Calculate gain neglecting the beam loading.

(iii) Find out the efficiency of the amplifier.

Q7. (a) Explain the working principle of a TWT amplifier from neat the sketch. How a TWT is different from a Klystron? (13

(b) "Magnetron is one of the mostly used oscillators with a complicated design"—How this oscillations are produced? Explain with several schematics. (14)

(c) A cylindrical magnetron has the following operating parameters: (08)

Anode voltage	:	V_0 = 30 kV
Beam current	:	I_0 = 35 mA
Magnetic flux density	:	B_0 = 0.40 Wb/m^2
Radius of cathode cylinder	:	a = 5 cm
Radius of vane edge to center:		b =15 cm

Calculate:

(i) The angular frequency

(ii) The cut-off voltage V_0 and magnetic flux density B_0

Q8. (a) What is Smith chart? Show that it consists of *x* and *r* circles. (15)

(b) For the transmission line shown in Fig. Q8(b), (20)

(i) Find the distance of 1st V_{min} from the generator.

(ii) Determine the 2nd I_{max} from the generator.

(iii) A short-circuited lossless stub is attached as shown in the figure to match the generator with the line. The characteristic impedance of this stub is 300 Ω. Determine the distance (*d*) of the stub from the generator end and the length (*l*) of the stub.

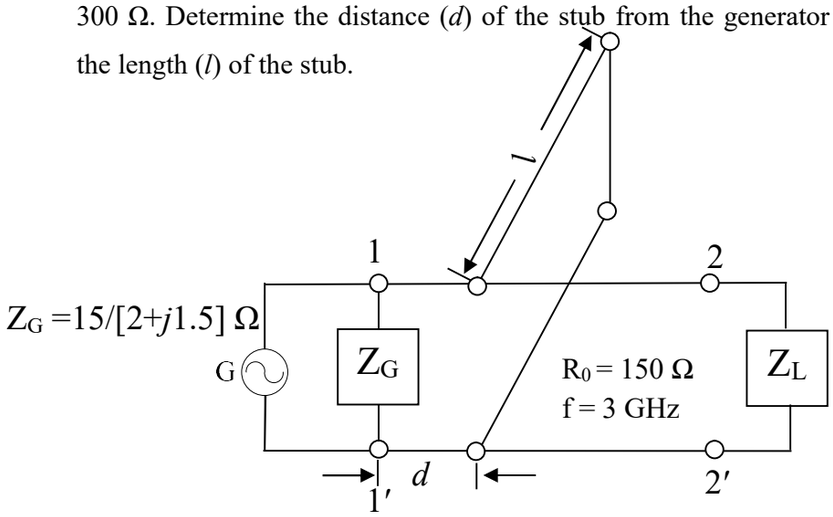


Fig. Q8(b).

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2018
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) What is meant by power plant? What are the advantages of thermal power station? (07)

(b) Compare diesel power plant with nuclear power in terms of cost of fuel transportation, cleanliness and simplicity. (10)

(c) What would be an ideal place for hydroelectric power plant? Explain your choice in terms of site selection criteria? (11)

(d) What are the effects of variable load on power stations? (07)

Q2. (a) What is load curve? What is its significance in power generation? Explain the differences between load curve and load duration curve. (10)

(b) Define load factor and diversity factor. Prove that an increase in diversity of load improves the load factor of a power system. (10)

(c) What are the factors to be considered for load forecasting? (05)

(d) Define capacity factor and plant use factor. A central power station has annual factors as follows: (10)
Load factor = 60%; capacity factor = 40%; use factor = 45%.
Power station has a maximum demand of 15,000 kW. Determine
(i) Annual energy production.
(ii) Reserve capacity over and above peak load.
(iii) Hours per year not in service.

Q3. (a) What is meant by substation? Explain different types of substation according to service requirement and constructional feature. (15)

(b) Draw the key diagram of a 11 kV/400 V indoor substation. (10)

(c) Explain the bathtub curve and its major distinguishable periods. (10)

Q4. (a) Derive the relationship between reliability and failure rate for equipment with constant failure rate. (08)

(b) Define MTTF? Derive the relation between MTTF and failure rate for system with two subsystem connected in parallel. Assume each sub system has the same failure rate. (08)

(c) Explain the reliability analysis process of partially redundant system. (10)

(d) Find the reliability of the following system using Baye's theorem. (09)

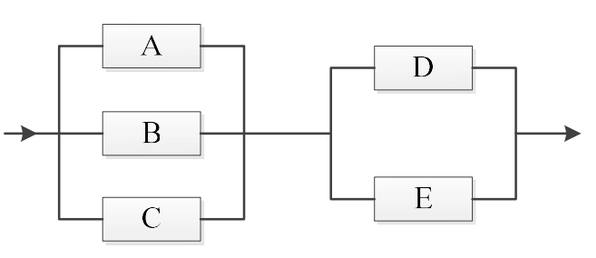


Fig. for Q4(d).

Section B

Q5. (a) "A steam power plant works basically on Rankine cycle"—Justify the statement clearly. (05)

(b) Draw and explain the essential parts of a steam power plant. (12)

(c) What are the functions of spillways, surge tank, and penstocks in a hydro-electric power station? (06)

(d) A hydro-electric power station has a reservoir of area 2.4 square kilometres and capacity $5 \times 10^6\ m^3$. The effective head of water is 100 metres. The penstock, turbine, and generation efficiencies are respectively 95%, 90%, and 85%. (12)

(i) Calculate the total electrical energy that can be generated from the power station.

(ii) If a load of 15,000 kW has been supplied for 3 hours, find the fall in reservoir level.

Q6. (a) Define binding energy and mass effect. "Higher the binding energy per nucleon, higher is the stability"—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 is meant 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)

Q7. (a) Classify nuclear reactors based on core, moderator, coolant, fuel used and energy of neutrons. What are the functions of moderator and control rod in a nuclear reactor? (10)

(b) What are the basic factors to be considered during the design of a nuclear reactor? Draw and explain the operation of Sodium Graphite Reactor (SGR). (12)

(c) Define conservation ratio. Why fast breeder reactor does not require any moderator? (07)

(d) Define thermal neutrons and epithermal neutrons. A nuclear reactor uses U^{235} as fuel. If the mass of fuel is 1.2 kg and neutron flux is 10^{16} per second, calculate the power of the reactor. (06)

Q8. (a) Explain standalone and grid-connected PV systems with proper diagrams. (08)

(b) What is power coefficient of wind? Draw and explain the basic components of a wind energy conversion system. (10)

(c) What is tidal power? Describe the operation of single basin one way tidal power plant. (05)

(d) Explain the energy generation from the following sources: (12)

(i) MHD generator

(ii) Thermo-electric power generator

(iii) Fuel cell.

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2018
Department of Electrical and Electronic Engineering
EE 4223
High Voltage DC and Flexible AC Transmission

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) Mention five advantages and inherent problems of HVDC over AC transmission. Define and explain break even distance in HVDC using proper illustration. (10)

(b) Write down the type of HVDC links. Which type is being used in Bangladesh? Draw the schematic diagram of any one type of the HVDC links identifying the main components. State at least two functions of each component. (15)

(c) Prove that around 40 percent more power can be transmitted using 50 percent less copper in HVDC system than HVAC. (10)

Q2. (a) What are the converters used for HVDC transmission? Draw the circuit diagram of a voltage source converter and explain the current control of the converter. (13)

(b) Explain the basic principle of operation of a shunt-active filter with neat sketch of block diagram and waveforms. (12)

(c) A six-pulse HVDC converter is connected to 330 kV AC grid using a 330 kV/220 kV, 800 MVA, X_t = 12% transformer. Determine the commutation overlap angle if the converter is operating at 20° firing angle and an 1800 A DC current. (10)

Q3. (a) What is the main drawback of LCC. Explain the operating principle of a two level single-phase VSC indicating possible current paths. (10)

(b) For a line commutated converter deduce the equations for dc and ac side harmonics. (10)

(c) A single-phase VSC inverter has pure inductive load with L = 21.5 mH. The inverter operates in a square wave fashion with an AC frequency of 50 Hz and DC voltage of 200 V. (15)

(i) Express the instantaneous converter voltage and load current using the Fourier series,

(ii) Calculate the peak and RMS load current, and

(iii)Calculate the power absorbed by the load.

Q4. (a) Explain the inverter operation of a three-phase converter. (10)

(b) Mention the operating mode of VSC. How does a VSC act as an inverter and reactive power controller? Explain with proper vector diagrams. (08)

(c) Sketch the circuit diagram of neutral point clamped multilevel converter and explain the principle of operation. (12)

(d) State and briefly explain multi-terminal HVDC. (05)

Section B

Q5. (a) Explain the construction and operation of TCR and TSC. Explain the operating characteristic of TCR and multiple TSC based static var compensator. Deduce the equation for SVC current. Draw the SVC characteristic with mismatched TCR and TSC. (10)

(b) Draw and explain general SVC control scheme. Explain the current measurement system for SVC. (09)

(c) Explain the IEEE Base Model-I for the SVC control system. (08)

(d) A TCR has a reactance 0.52 Ω and firing angle $\alpha = 40°$. Find out β_{TCR}. (08)

Q6. (a) Explain the load sharing aspect of parallel connected SVCs. Deduce the equation for ESCR. (10)

(b) Describe the application of SVC for (i) enhancement of power system transient stability and (ii) augmentation of power system damping. (13)

(c) An SVC connected to a 735 kV system has a reactive power range of 350 MVAR production to 100 MVAR absorption. The droop is set to 5%. The system short circuit level is specified as follows: (12)

Maximum short-circuit current, 50 kA

The minimum short-circuit current under normal operating conditions, 5 kA

The minimum short-circuit current during system restoration after loss of transmission line, 500 A.

Determine

(i) the pu regulator gain that ensures stable operation from 5 kA to 50 kA system short-circuit current,

(ii) the change of voltage-control response for the system variation and regulator setting in (i) and

(iii) the pu regulator gain for stable operation of the system.

Q7. (a) Draw the schematic diagram of a TCSC module used in practice and explain its operation. What are the advantages and requirements of TCSC? Explain the modes of TCSC operation with necessary diagrams. (13)

(b) Explain the constant current and constant angle control modes of TCSC. (12)

(c) Deduce and explain the steady state model of a STATCOM. (10)

Q8. (a) Describe the applications of SSSC in power system. (10)

(b) Draw the schematic diagram of a UPFC and explain the different control modes of UPFC. (11)

(c) Explain real power and var control methodology of a UPFC. Explain the maximum and minimum power and var control characteristics. (14)

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2018
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? Describe the fundamental steps for digital image processing. (11)

(b) Explain Sampling and Quantization in image processing. (08)

(c) Mention the differences between spatial and tonal resolution. (06)

(d) Obtain D_e (p,q), D_4 (p,q), D_8 (p,q), and D_m (p,q), for the following image. (10)

	0	1	2	3	4	5	
0	3	4	6	6	7	6	x
1	6	4	7	7	6	4	
2	2	3	4	5	5	3	
3	7	1	0	3	7	7	
4	6	5	4	0	4	3	
5	6	4	3	0	0	4	
y							

Assume V = {3,4} and p = (0,0); q = (5,5).

Q2. (a) What do you mean by energy compaction? Mention the properties of slant transform. (08)

(b) Determine the median output for the following 1-D function if $y(m) = \{2,3,8,4,2\}$ and windows are (i) $w = \{-1,0,1\}$ (08)

(ii) $w = \{-1,0,1,2\}$

(c) Explain different distance measurement criteria and m-connectivity of digital image. For the following arrangement of pixels, what is the value of chessboard and city-block distance between the circled two points and justify that whether they are m-connected or not. (13)

$$I = \begin{matrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & (1) & 1 \\ 0 & 1 & 0 & 0 & 1 \\ 0 & (1) & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \end{matrix}$$

(d) Write down the application of 2D Fourier transform and 2D z-transform. (06)

Q3. (a) Explain sampling theorem for image. Find the 2D Discrete Fourier Transform for the following image matrix: $\begin{bmatrix} 4 & 8 \\ 3 & 5 \end{bmatrix}$. (08)

(b) Define zooming and shrinking of image. For the following image, apply zooming using Nearest neighbor interpolation and Bilinear interpolation technique. (08)

$$I = \begin{bmatrix} 75 & 49 & 30 \\ 50 & 11 & 121 \\ 55 & 12 & 232 \end{bmatrix}$$

(c) Find 2D z-transform for the following: (08)

$$u(n_1, n_2) = \begin{cases} 1, & n_1 \geq 0, n_2 \leq 0. \\ 0, & \text{else} \end{cases}$$

Also, find ROC for this sequence. For the following binary sequence:

0	0	1	1	0	0	1	0

Shift 2 bits to the right and 2 bits to the left. Also, find the decimal number.

(d) What is noise of an image? Mention the causes of noise and explain how it is estimated? (07)

(e) Classify noise with proper mathematical expressions. (04)

Q4. (a) Mention the design criteria of Gaussian Kernels. "Faithful Gaussian Kernel cannot be built using 3×3 mask"—Justify the statement. (08)

(b) Mention the advantages of slant transform. Find 1D slant transform for the following sequence: $\begin{bmatrix} 1 \\ 3 \\ 5 \\ 7 \end{bmatrix}$. Also, calculate total energy compaction. (07)

(c) Show that, for unitary transform, the determinant has unit magnitude and the eigen values also have unit magnitude. (08)

(d) Find the transformed output image matrix using K–L transform for the following given image matrix. (12)

$$U = \begin{bmatrix} 2 & 5 & 3 & 2 & 4 & 3 \\ 2 & 5 & 4 & 3 & 3 & 4 \end{bmatrix}$$

Section B

Q5. (a) Why compression is needed for digital image processing? What are the different techniques of image representation? Calculate file size of a binary, gray level, and color image whose resolution is 1200×600. (07)

(b) Define the terms for an image: (i) Brightness (ii) Contrast (iii) Dithering. Write down the elaboration of the popular file formats: (i) GIF (ii) JPEG (iii) PNG (iv) TIFF (v) EXIF (vi) PDF. (10)

(c) What is entropy of a system? Define lossless and lossy data compression techniques. For the given sequence find the run-length and savings of Bits using run-length coding. (08)

111111111111111100000001111110101000000101011111111000 01

(d) Construct the codeword and calculate entropy for "ELECTRICAL" using Huffman coding. (10)

Q6. (a) What is histogram equalization? Why this is needed? For the following image, equalize the histogram. (12)

$$\begin{bmatrix} 5 & 2 & 3 & 7 \\ 3 & 3 & 1 & 1 \\ 5 & 2 & 8 & 7 \\ 2 & 2 & 3 & 1 \end{bmatrix}$$

(b) Mention the specifications of histogram equalization. Write down the properties of erosion and dilation with proper definition. (06)

(c) Define Hit or Miss transform of an image. For two images, (08)

$A = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$, what will be the transformed image using Hit and Miss transform?

(d) For the following image and structuring element, perform opening and closing operations. (09)

Image

$$\begin{bmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}$$

Structural element

1	1	1

Q7. (a) What are the features of an image? Mention the causes of edge. Detect edge using Prewitt operator for the following image using center pixel. (12)

0	30	60
5	32	62
10	38	64

(b) Determine the edges using minimum cost method for the following image. Assuming that edge start in the first row and end in the last row. (11)

5	6	1
6	7	0
7	1	3

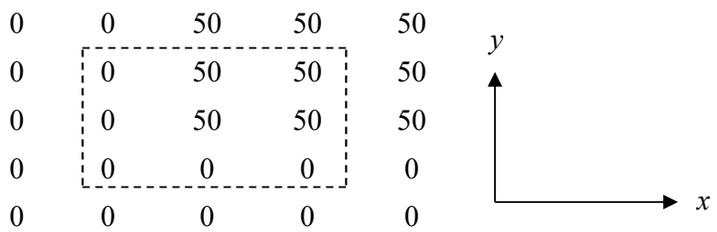
(c) What do you mean by bit plane slicing and intensity level slicing? For the given 3-bit image below perform- (i) bit plane slicing and (ii) intensity level slicing with background $R_1 = 3$ and $R_2 = 5$. (12)

6	2	3	2
1	5	0	7
4	3	2	1
2	5	7	6

Q8. (a) Define morphology. What are the different types of morphological operations? Mention the characteristics of erosion. (07)

(b) Why image segmentation is useful? Write down the significant issues of region growing, also write down its applications. (12)

(c) Consider the following sub image: (08)



Consider a 3×3 neighborhood. Using backward difference, compute the eigen values for a corner detector. If the threshold is 1500, will it be considered as a corner?

(d) Find the resulting dithered binary image of the dither matrix (08)

$\begin{bmatrix} 0 & 8 & 2 & 10 \\ 12 & 4 & 14 & 6 \\ 3 & 11 & 1 & 9 \\ 15 & 7 & 13 & 5 \end{bmatrix}$, and the 2×2, 8 bit gray level image as the input is $\begin{bmatrix} 200 & 250 \\ 100 & 50 \end{bmatrix}$.

Khulna University of Engineering & Technology
B. Sc. Engineering 4th Year 2nd Term (Regular) Examination, 2018
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 shunt motor does not operate with ac supply but a dc series motor operate with ac supply. Explain the dc and ac characteristics and improvement of the characteristics with phasor diagrams and torque speed curves. (13)

(b) Classify repulsion motor. Write the advantages and disadvantages of each category with its circuit diagrams and torque speed characteristics. Why have repulsion motor largely been replaced by capacitor-type motors? (12)

(c) A universal series motor has resistance of 30 Ω and an inductance of 0.5 H. When connected to a 250 V DC supply and loaded to take 0.8 A, it runs at 2000 RPM. Estimate its speed and power factor, when connected to a 250 V, 50 Hz AC supply and loaded to take the same current. (10)

Q2. (a) Shaw that a hysteresis motor is a constant torque motor. Describe the normal and inverted construction of the rotor and its applications. (10)

(b) Describe the construction of reluctance motor. How does a reluctance motor pull into step? Draw the torque-speed characteristic of a reluctance motor and indicate pull-in torque. (10)

(c) Explain the construction and operation of a switched reluctance motor. (07)

(d) What is a linear induction motor? Explain its operation and application. (08)

Q3. (a) Describe the different types of rotors used in stepper motor. Explain the half step operation of a VR reluctance motor with truth table and necessary diagrams. Explain the micro stepping technique. (10)

(b) Explain the construction and characteristics of DC and AC servo motors. What are the advantages of AC servo motors over DC servo motors? (08)

(c) What are synchros? Describe the application of synchros for torque transmission. (09)

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

Q4. (a) Describe the construction of IPM and SPM synchronous motors. Why is $L_q > L_d$ for an IPM SM? Deduce the mathematical model of the motor. (12)

(b) Write down the equations of SPM SM and draw a block diagram for close loop motor speed control. (10)

(c) Show that a PMBLDC motor is a trapezoidal field motor. Write down its mathematical model and suggest a control block diagram for close loop control of speed. What are its applications? (13)

Section B

Q5. (a) Write down the equation for incremental energy of an electro mechanical system and explain the terms. (10)

(b) Deduce the equation for field force of a singly excited electromechanical system. (10)

(c) In the electromagnetic relay shown below $L_{11} = \frac{k_1}{x}$, $L_{22} = \frac{k_2}{x}$ and $L_{12} = L_{21} = \frac{k_3}{x}$. Find the expression for the force on the armature if $i_1 = I_1 \sin \omega_1 t$, $i_2 = I_2 \sin \omega_2 t$. Write an expression for the average force. For what relationship ω_1 and ω_2 the average force is (i) maximum (ii) minimum. (15)

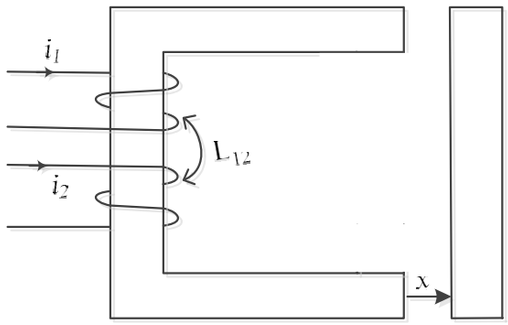


Fig. for Q5(c).

Q6. (a) For a multiply excited magnetic field system deduce the equations for energy and co-energy. Also, deduce the equations for torque. (15)

(b) For a multiply excited magnetic system, the inductances in henrys are given as- $L_{11} = (3 + \cos 2\theta) \times 10^{-3}$; $L_{12} = 0.3 \cos \theta$; $L_{22} = 30 + 10 \cos 2\theta$. Find the torque T_{fld} (θ) for current $i_1 = 0.8$ A and $i_2 = 0.01$ A. (12)

(c) Define electrical drive. Draw the generalized block diagram of an electrical drive. (08)

Q7. (a) Draw the torque-speed characteristics of polyphase induction motor showing forward motoring, reverse plugging and forward regeneration regions of operation. (08)

(b) How the speed of a wound rotor induction motor is controlled by injecting a voltage in the rotor circuit? Describe static Scherbius drive with proper diagram as slip power recovery scheme. (15)

(c) A 440 V, 50 Hz, 6-pole, Y-connected wound rotor motor has the following parameters: $R_s = 0.5\ \Omega$, $R_r' = 0.4\ \Omega$, $X_s = X_r' = 1.2\ \Omega$, $X_m = 50\ \Omega$, and stator to rotor turns ratio is 3.5. Motor is controlled by static rotor resistance control. External resistance is chosen such that the breakdown torque is produced at standstill for a duty ratio of zero. Calculate the value of external resistance. How duty ratio should be varied with speed so that the motor accelerates at maximum torque. (12)

Q8. (a) Define vector control. Discuss the basic principle of vector control of induction motor. (10)

(b) Explain direct and indirect field-oriented controls of induction motor with proper block diagram representations. (13)

(c) Discuss field oriented current fed PMBLDC motor drive with neat sketch. What is the major difference between FOC of induction motor drive and FOC of PMBLDC motor drive? (12)