L-2/T-2/EEE Date : 08/12/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2012-2013

Sub : **EEE 205** (Energy Conversion II)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

The questions are of equal value.

1. (a) Draw the equivalent circuit of a cumulatively compounded DC generator and also draw its terminal characteristics with different number of series field turns. Also identify each curve by its technical name.

(b) A DC shunt generator with an armature resistance of 0.5 Ω has the following data for its open circuit characteristic curve at 1800 rpm. Draw the OCC curve.

I_f (Amp)	1.0	2.0	3.0	4.0	5.0	6.0	7.0
E_a (volt)	100	200	300	370	410	440	460

If the total field resistance is 90 Ω:

(i) What is the generator's no load terminal voltage?

(ii) What would be the no load terminal voltage if the rotational speed were 1600 rpm?

(iii) Find the critical resistance.

(iv) What is the terminal voltage of the generator with an armature current of 50 Amp. (neglect armature reaction)?

2. (a) (i) What is acid rain? Does a wind turbine generator contribute towards acid rain? Draw a typical wind speed-power curve of a wind turbine generator and indicate its key features on the graph.

(ii) Draw current-voltage characteristics of a typical silicon PV cell under standard test conditions. Is it possible to estimate the maximum power from this curve? If so, indicate the point on the graph.

(b) A WTG of 225 watt rated power output is operating at an annual capacity factor of 0.025. Its capital cost is 50,000 \$. The required annual rate of return is 10% and the investment is to be recovered in 10 years. Calculate the cost of electricity generation by this WTG if the factor representing the annual operating cost is K = 0.025. Given : 1 year = 8760 hours.

3. (a) Draw the terminal characteristic curves for (i) separately excited (ii) shunt DC generators ignoring armature reaction. What is difference between these two curves and why?

(b) Draw the terminal characteristic curves of a DC shunt motor with and without considering the armature reaction. Illustrate the characteristic with armature reaction with appropriate numerical example.

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4. (a) Draw the DC motor staring circuit using time delay relays. What is the function of the relay contact in parallel with 'start' pushbutton switch?

(b) A DC shunt motor with an armature resistance of 0.06 Ω and a flux of 0.05 Wb. per pole is rotating at a speed of 1200 rpm with a supply voltage of 230 Volts when it draws an armature current of 100 Amp. Determine the value of the additional resistance in the armature circuit which will be required to reduce the speed at 1000 rpm with all other conditions remaining same.

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

All the symbols and notations used in this part have their usual meanings.

5. (a) What is the principal difference between a synchronous machine and an induction machine? Draw the brushless excitation scheme for an alternator that includes a pilot exciter. Explain the working principle of this exciter. **(9)**

(b) Is the synchronous reactance of an alternator constant over the entire region of its OCC? Sketch the approximate synchronous reactance of an alternator as a function of the field current in the machine. Show the OCC, SCC and the air-gap line on the sketch. What is the short-circuit ratio of a generator? **(11)**

(c) A 2300-V, 1000-kVA, 0.8-PF-lagging, 50-Hz, 2-pole, Y-connected synchronous generator has a synchronous reactance of 1.1 Ω and an armature resistance of 0.15 Ω. At 50 Hz, its friction and windage losses are 24 kW, and its core losses are 18 kW. The field circuit has a DC voltage of 200 V, and the maximum I_F is 10 A. The resistance of the field circuit is adjustable over the range from 20 to 200 Ω. The OCC of this generator is shown in Fig. for Q. No. 5(c). **(15)**

(i) What is the internal generated voltage of this machine at rated conditions?

(ii) How much field current is required to make V_T equal to 2300 V when the generator is running at rated conditions?

(iii) How much power must the generator's prime mover be capable of supplying?

6. (a) Suppose that you were an engineer planning a new electric cogeneration facility for a plant with excess process stream. You have a choice of either two 10-MW turbine-generators or a single 20-MW turbine-generator. What would be the advantages and disadvantages of each choice? **(8)**

(b) How can the real power sharing between two generators be controlled without affecting the system's frequency? How can the reactive power sharing between two generators be controlled without affecting the system's terminal voltage? **(10)**

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Contd ... Q. No. 6

(c) A paper mill has installed three steam generators (boilers) to provide process steam and also to use some its waste products as an energy source. Since there is extra capacity, the mill has installed three 5-MW turbine generators to take advantage of the situation. Each generator is a 4160-V, 6250-kVA, 0.85-PF-lagging, 2-pole, Y-connected synchronous generator with a synchronous reactance of 0.75 Ω and an armature resistance of 0.04 Ω. **(17)**

Generators 1 and 2 have a characteristic power-frequency slope s_p of 2.5 MW/Hz, and generators 2 and 3 have a slope of 3 MW/Hz.

(i) If the no-load frequency of each of the three generators is adjusted to 51 Hz, how much power will the three machines be supplying when actual system frequency is 50 Hz?

(ii) What would the internal generated voltages of the three generators be under this condition?

7. (a) Show the effect of load changes on a synchronous generator operating alone. What will happen to the same generator if field excitation changes? **(10)**

(b) Describe the general procedure for paralleling generators. Can the same procedure be followed to parallel a generator with a large power system? **(10)**

(c) What are the basic approaches that can safely be used to start a synchronous motor? Show the development of a unidirectional torque in synchronous motor with amortisseur windings. **(15)**

8. (a) When would a synchronous motor be used even though its constant-speed characteristic was not needed? Explain, using phasor diagrams, what happens to a synchronous motor as its field current is varied. Derive a synchronous motor V curve from the phasor diagram. **(10)**

(b) Draw the torque versus torque-angle curve for a salient-pole synchronous motor. Note the component of torque due to rotor reluctance. Is this motor more stable in comparison with a non-salient pole motor of same capacity? **(10)**

(c) A 208-V, Y-connected synchronous motor is drawing 40 A at unity power factor. The field current flowing under these conditions is 2.7 A. Its synchronous reactance is 0.8 Ω. Assume a linear open-circuit characteristic. **(15)**

(i) Find the torque angle.

(ii) How much field current would be required to make the motor operate at 0.8 PF leading?

(iii) What is the new torque angle in (ii)?

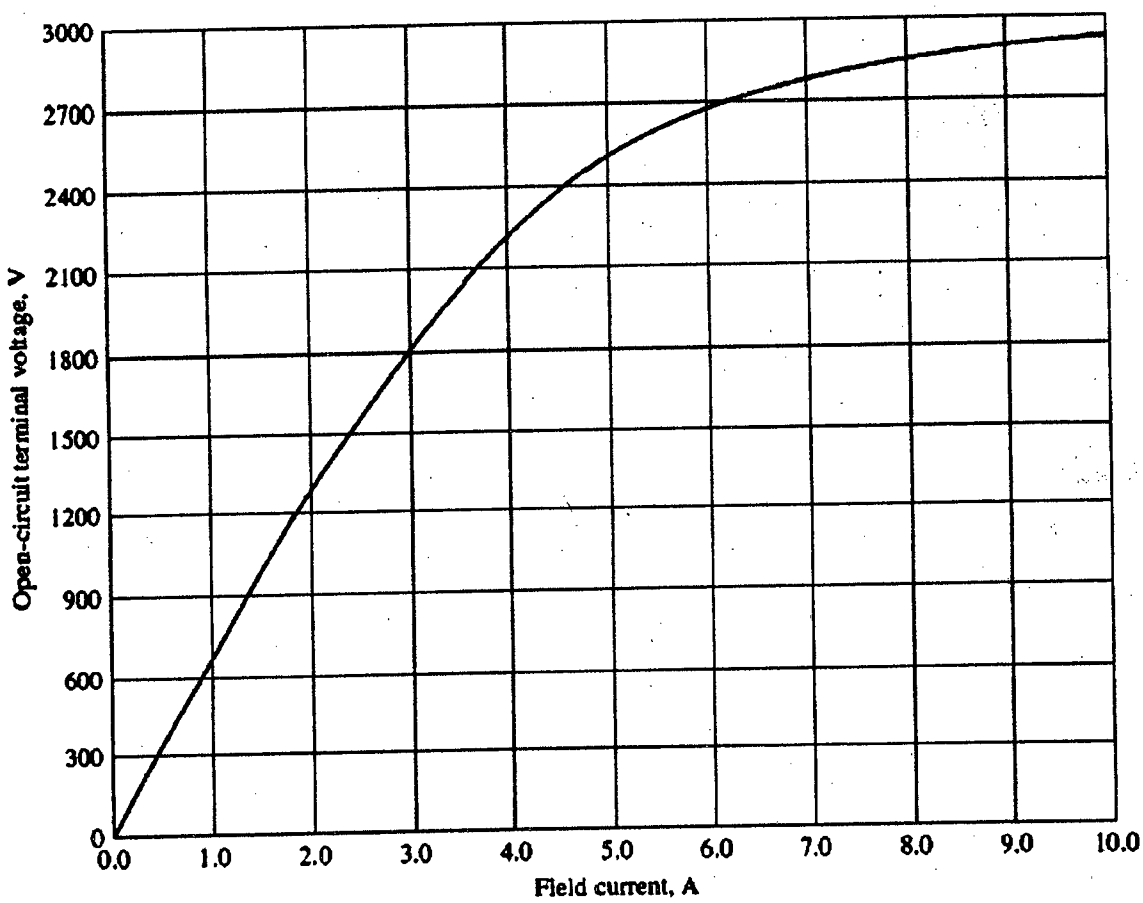

Fig. for Q. No. 5(c).

L-2/T-2/EEE **Date : 06/01/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B.Sc. Engineering Examinations 2012-2013

Sub : **EEE 209** (Engineering Electromagnetics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

Symbols have their usual meanings.

1. (a) Define Electric Scalar Potential. Prove that $\vec{E} = -\nabla V$ and $V = -\int_l \vec{E}\cdot\vec{dl}$. **(8)**

(b) Consider two radial conducting plates located at $\phi = 0$ and $\phi = \infty$ $\phi = \alpha$ in cylindrical co-ordinates as shown in Figure 1(b). The plates are separated by a thin layer of dielectric having a dielectric constant of ε_r along the z-axis. The static electric potential of the plates are taken as V_a and V_b in the Figure. Find the electric scalar potential at any point in the dielectric region, $\vec{E}$, and the surface charge density at a point on either of the plates. **(18)**

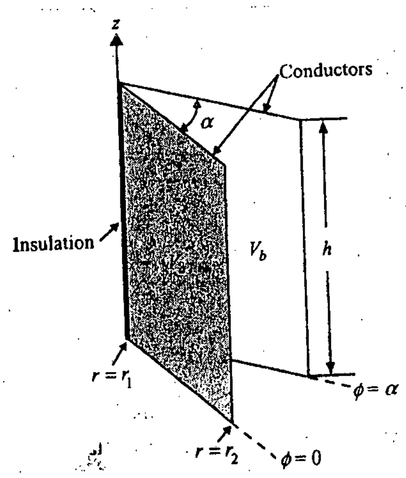

Fig. Q. 1(b)

(c) A line charge of uniform charge density ρ_l forms a semicircle of radius b in the upper half xy plane. Determine the magnitude and direction of the electric field intensity at the center of the semicircle. **(9)**

2. (a) Why are there no free charges in the interior of a conductor under static conditions? Explain with necessary equations. **(6)**

(b) Derive the general boundary conditions for $\vec{E}$ and $\vec{D}$ at an interface between two different dielectric media with dielectric constants ε_{r1} and ε_{r2} from fundamental postulates of Electrostatics in integral form. **(8)**

(c) Show that the magnitude of the electric field intensity of an electric dipole along the z-axis at a point (R, θ, φ) is 12

$$E = \frac{P}{4\pi\varepsilon_o}\frac{1}{R^3}[1+3\cos^2\theta]^{1/2} \text{ V/m.}$$

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(d) Define electric polarization vector and electric susceptibility. Give their units. The permittivity of a loss-free homogeneous dielectric Material is $\varepsilon = 44.25 \times 10^{-12}$ F/m. The electric field intensity in the material is 2.5 kV/m. Find (i) the electric susceptibility (ii) electric polarization and (iii) moment of a dipole if there are 9×10^6 dipoles per volume. **(9)**

3. (a) Show that the torque experienced by a current carrying circuit in a magnetic field is given by $T = \vec{M} \times \vec{B}$ (N-M). **(12)**

(b) A direct current I flows in an infinitely long wire of a radius 3 mm along the z - axis. (i) Obtain the Vector magnetic potential $\vec{A}$ at r > 3 mm. Choose the reference zero potential at wire surface.

(ii) If I = 15 A, determine from the vector magnetic potential ($\vec{A}$), the total amount of magnetic flux passing through a rectangular loop specified by $z = \pm 0.3$ m and y = 0.2 m and 0.7 m. **(13)**

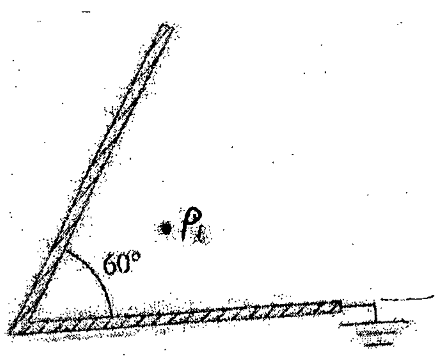
(c) Region 1, described by $3x + 4y \geq 10$ is free space whereas region 2 described by $3x + 4y \leq 10$ is a magnetic material for which $\mu = 10\,\mu_0$. Assuming that the boundary between the material and free space is current free, find B_2 in region 2 if B_1 in region 1 is $0.1\hat{a}_x + 0.4\hat{a}_y + 0.2\hat{a}_z$ wb/m^2. **(10)**

4. (a) A coaxial cable consists of a long cylindrical conductor of radius a surrounded by a cylindrical shell of inner radius b and outer radius c. The inner conductor and the outer shell each carry equal and opposite currents I uniformly distributed through the conductors. Obtain expressions for the magnetic field intensity in each of the regions (i) $r \leq a$ (ii) $a \leq r \leq b$ (iii) $b \leq r \leq c$ and (iv) $r \geq c$. **(10)**

(b) A long and straight co-axial transmission line has an inner solid conductor of radius 5 mm and an outer conductor of inner radius, 12 mm. It is connected to a load which takes 25 A. Calculate the magnetic energy stored in the region between the conductors for one meter length of the line. Also calculate the external inductance per unit length of the line using the calculated magnetic energy stored. **(10)**

(c) Explain image theory. Mention the conditions that are to be satisfied in applying this theory. Determine the system of image charges that will replace the conducting boundaries that are maintained at zero potentials for the system having a line change of density (ρ_l)as shown in Fig. 4(c). **(8)**

Fig for Q. 4(c)



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(d) A line charge of large length is parallel to a large conducting plate in free space. The conducting plate is on the x-z plane and the line charge is at y = 2.4 m. Find the potential at P(3 m, 4 m, 0). The line charge has a line charge density 4 nC/m. **(7)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) What is the displacement current? What is its significance in a capacitive circuit? **(8)**

   (b) A 50 V voltage generator at 20 MHz is connected to the plates of an air dielectric parallel-plate capacitor with plate area 2.8 cm^2 and separation distance 0.2 mm. Find the maximum value of displacement current density and displacement current. **(12)**

   (c) Show that in a linear homogeneous, isotropic source-free region, both $\vec{E}_s$ and $\vec{H}_s$ must satisfy the wave equation. **(15)**

$$\nabla^2 \vec{A}_s + \gamma^2 \vec{A}_s = 0$$

$$\text{where } \gamma^2 = \omega^2 \mu\varepsilon - j\omega\mu\sigma \text{ and } \vec{A}_s = \vec{E}_s \text{ or } \vec{H}_s.$$

6. (a) Explain why the magnetic field can change the direction of motion of a charged particle, but cannot change its speed. **(8)**

   (b) What is meant by the polarization of wave? When is a wave linearly and circularly polarized? **(12)**

   (c) A 2 m long conductor is carrying 3 A current. The conductor is placed parallel to the z-axis at a distance ρ_o = 10 cm. If the field in the region is $\cos(\phi/3)\ \hat{a}_\rho$ Wb/m^2, how much work is required to rotate the conductor one revolution about the z-axis? **(15)**

7. (a) Show that the energy carried by electromagnetic waves in a coaxial cable is mainly through the dielectric material between the conducting cores. **(8)**

   (b) Show that the reflection coefficient of a normally incident electromagnetic wave being incident on a perfect conductor from a perfect dielectric is – 1. **(12)**

   (c) A beam of yellow light with wavelength of 0.6 μm is normally incident from air upon a glass surface. If the surface is situated in the plane z = 0 and the relative permittivity of glass is 2.25, determine **(15)**

      (i) the locations of the electric field maxima in medium 1 (air),

      (ii) the fraction of the incident power transmitted into the glass medium.

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8. (a) Show that in a good conductor, the skin depth δ is always much shorter than the wavelength. **(8)**

(b) The amplitude of a wave traveling through a lossy nonmagnetic medium ($\mu = \mu_0$) reduces by 18% every meter. If the wave operates at 10 MHz and the electric field leads the magnetic field by 24°, calculate (a) the propagation constant, (b) the wavelength, (c) the skin depth, (d) the conductivity of the medium. **(12)**

(c) A uniform wave in a lossy nonmagnetic ($\mu = \mu_0$) media has **(15)**

$$\vec{E}_s = \left(5\hat{a}_x + 12\hat{a}_y\right)e^{-\gamma z}, \text{ where } \gamma = 0.2 + j3.4/\text{m}.$$

(i) Compute the magnitude of the wave at z = 4 m.

(ii) Find the loss in dB suffered by the wave in the interval $0 < z < 3$ m.

(iii) Calculate the Poynting vector at $z = 4$, $t = T/8$, where T is period. Assume $\omega = 10^8$ rad/s.

L-2/T-2/EEE **Date : 11/01/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2012-2013

Sub : **ME 267** (Mechanical Engineering Fundamentals)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Assume reasonable value for any missing data. Symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Why is Carnot cycle not practicable for a steam power plant? **(5)**

(b) Explain with the help of necessary T-s diagrams, the effects of boiler and condenser pressures on the efficiency of Rankine vapor power cycle. **(10)**

(c) Consider a steam power plant that operates on the ideal-reheat Rankine cycle. The plant maintains the inlet of the high-pressures turbine at 4 MPa and 300°C, the inlet of the low-pressure turbine at 1.4 MPa and 300°C, and the condenser at 75 kPa. The net power produced by this plant is 5 MW. Necessary steam property tables are attached. Determine- **(20)**

(i) The rate of heat addition

(ii) The rate of heat rejection

(iii) Thermal efficiency of the cycle.

2. (a) What do you understand by thermal contact resistance? What are the factors that affect thermal contact resistance and how can you minimize it? **(10)**

(b) Distinguish between free and forced convection heat transfer. **(5)**

(c) Why non-metallic crystals such as diamond and graphite can have higher thermal conductivity than pure metals? **(5)**

(d) The wall of a refrigerator is constructed of fiberglass insulation (k = 0.03 W/m.°C), as shown in the figure for Q. No. 2(d). The refrigerated space is maintained at 3°C. The average heat transfer coefficients at the inner and outer surfaces of the wall are 5 W/m^2/°C and 10 W/m^2.°C, respectively. The average kitchen temperature is 25°C. It is observed that condensation occurs on the outer surfaces of the refrigerator when the temperature of the outer surface drops to 20°C.

Determine the minimum thickness of fiberglass insulation that needs to be used in order to avoid condensation on the outer surfaces. Assume that the condensation on the outer surface can be avoided at an outer wall surface temperature of 10°C. **(15)**

[N.B. See the next page for Figure for Question No. 2(d)].

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3. (a) What is a refrigerant? What factors should you consider for the selection of a suitable refrigerant? **(8)**

(b) Explain with necessary diagram how the actual vapor compression refrigeration cycle differs from the ideal one. **(10)**

(c) A refrigeration plant is running on an ideal vapor-compression refrigeration cycle. The saturated refrigerant vapor coming out of the evaporator has an enthalpy of 245.6 kJ/kg and the superheated refrigerant vapor at the end of the compression process has an enthalpy of 305.3 kJ/kg. The mass flow of refrigerant is 0.1 kg/s and the amount of heat dissipated to the environment by the condenser is 20.0 kW. **(17)**

(i) Show this cycle on a *P-h* diagram and determine the refrigeration effect in Ton of refrigeration and the COP.

Now, assume that the compressor has an isentropic efficiency of 85%. Moreover, an isentropic turbine is used instead of the throttling device, and so the enthalpy of refrigerant at the evaporator entry is changed to 90.5 kJ/kg.

(ii) Determine the refrigeration effect and COP in this case assuming that the mass flow rate and other process points are not affected.

4. (a) With the help of T-s diagrams, briefly explain the effects of the following two modifications on the COP of an vapor compression refrigeration system – **(10)**

(i) The expansion valve is replaced with an isentropic turbine

(ii) The refrigerant is cooled during the compression process

(b) What is the function of thermostatic expansion valve in a vapor compression refrigeration system? Describe its working principle with necessary sketches. **(15)**

(c) A spherical ball of 5 mm diameter at 60°C is covered by a 1 mm thick plastic insulation (k = 0.12 W/m°C), as shown in figure for Q. No. 4(d). The ball is exposed to a medium at 15°C, with a combined convection and radiation heat transfer coefficient of 25 W/m^2°C. Determine if the plastic insulation on the ball will increase or decrease heat transfer from the ball. Mention all the assumptions that you have made in solving this problem. **(10)**

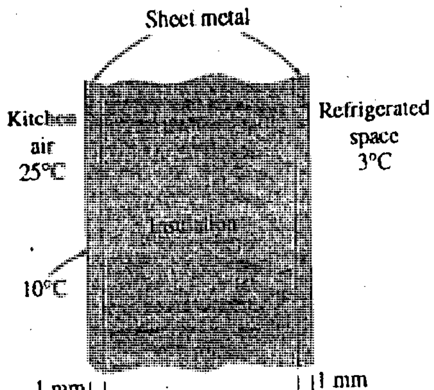

Figure for Q. No. 2(d)

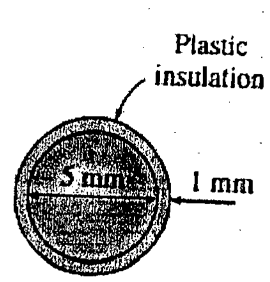

Figure for Q. No. 4(d)

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SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Name and describe three accessories required for the efficient running of a boiler. (With the schematic of a boiler plant) **(15)**

   (b) Mention different methods of calculating boiler efficiency. **(5)**

   (c) Write short note: (i) Higher heating value (ii) Flash point and fire point **(8)**

   (d) Describe the working principle of a pressurized reactor. **(7)**

6. (a) Derive Bernoulli equation along a streamline of a flow field with important validations. **(12)**

   (b) (i) Describe the working principle of a pelton wheel. **(10+5)**

   (ii) In a performance test of a pelton wheel it is found that the rotor drum is rotating at a speed of 420 rpm. Total head developed during the experiment is 24 m. If the rotor diameter is 30 cm, then find the tip speed ratio for the pelton wheel.

   (c) State the phenomenon of cavitation and its effects on a centrifugal pump. **(8)**

7. (a) Describe the deviations of an actual cycle from the ideal Brayton cycle. **(5)**

   (b) How does an intercoder and a reheater improves the efficiency of a Brayton cycle. Explain with necessary block diagram and T-s diagram. **(15)**

   (c) A Brayton cycle with regeneration using air as the working fluid has a pressure ratio of 7. The minimum and maximum temperature in the cycle are 310 and 1150 K. Assuming an insentropic efficiency of 75 percent for the compressor and 82 percent for the turbine and an efficiency of 65 percent for the regenerator. Determine: **(15)**

   (i) the net work output
   (ii) the air temperature at the turbine exit
   (iii) the thermal efficiency.

8. (a) Define: Mean effective pressure, back work ratio. **(5)**

   (b) Deduce the expression for a diesel cycle efficiency and hence show that for the same compression ratio and same energy input Otto cycle efficiency is greater than that of a diesel cycle efficiency. **(15)**

   (c) The compression ratio of an air-standard Otto cycle is 9.5. Prior to the isentropic compression process, the air is at 100 kPa, 35°C and 600 cm^3. The temperature at the end of the isentropic expression process is 800 K Using Specific heat values at room temperature, determine **(15)**

   (i) the highest temperature and pressure in the cycle.
   (ii) the amount of heat transfer ion,. in kJ.
   (iii) the thermal efficiency.
   (iv) the mean effective pressure.

Saturated water—Pressure table

		Specific volume, m³/kg		Internal energy, kJ/kg			Enthalpy, kJ/kg			Entropy, kJ/kg · K		
Press., P kPa	Sat. temp., T_{sat} °C	Sat. liquid, v_f	Sat. vapor, v_g	Sat. liquid, u_f	Evap., u_{fg}	Sat. vapor, u_g	Sat. liquid, h_f	Evap., h_{fg}	Sat. vapor, h_g	Sat. liquid, s_f	Evap., s_{fg}	Sat. vapor, s_g
1.0	6.97	0.001000	129.19	29.302	2355.2	2384.5	29.303	2484.4	2513.7	0.1059	8.8690	8.9749
1.5	13.02	0.001001	87.964	54.686	2338.1	2392.8	54.688	2470.1	2524.7	0.1956	8.6314	8.8270
2.0	17.50	0.001001	66.990	73.431	2325.5	2398.9	73.433	2459.5	2532.9	0.2606	8.4621	8.7227
2.5	21.08	0.001002	54.242	88.422	2315.4	2403.8	88.424	2451.0	2539.4	0.3118	8.3302	8.6421
3.0	24.08	0.001003	45.654	100.98	2306.9	2407.9	100.98	2443.9	2544.8	0.3543	8.2222	8.5765
4.0	28.96	0.001004	34.791	121.39	2293.1	2414.5	121.39	2432.3	2553.7	0.4224	8.0510	8.4734
5.0	32.87	0.001005	28.185	137.75	2282.1	2419.8	137.75	2423.0	2560.7	0.4762	7.9176	8.3938
7.5	40.29	0.001008	19.233	168.74	2261.1	2429.8	168.75	2405.3	2574.0	0.5763	7.6738	8.2501
10	45.81	0.001010	14.670	191.79	2245.4	2437.2	191.81	2392.1	2583.9	0.6492	7.4996	8.1488
15	53.97	0.001014	10.020	225.93	2222.1	2448.0	225.94	2372.3	2598.3	0.7549	7.2522	8.0071
20	60.06	0.001017	7.6481	251.40	2204.6	2456.0	251.42	2357.5	2608.9	0.8320	7.0752	7.9073
25	64.96	0.001020	6.2034	271.93	2190.4	2462.4	271.96	2345.5	2617.5	0.8932	6.9370	7.8302
30	69.09	0.001022	5.2287	289.24	2178.5	2467.7	289.27	2335.3	2624.6	0.9441	6.8234	7.7675
40	75.86	0.001026	3.9933	317.58	2158.8	2476.3	317.62	2318.4	2636.1	1.0261	6.6430	7.6691
50	81.32	0.001030	3.2403	340.49	2142.7	2483.2	340.54	2304.7	2645.2	1.0912	6.5019	7.5931
75	91.76	0.001037	2.2172	384.36	2111.8	2496.1	384.44	2278.0	2662.4	1.2132	6.2426	7.4558
100	99.61	0.001043	1.6941	417.40	2088.2	2505.6	417.51	2257.5	2675.0	1.3028	6.0562	7.3589
101.325	99.97	0.001043	1.6734	418.95	2087.0	2506.0	419.06	2256.5	2675.6	1.3069	6.0476	7.3545
125	105.97	0.001048	1.3750	444.23	2068.8	2513.0	444.36	2240.6	2684.9	1.3741	5.9100	7.2841
150	111.35	0.001053	1.1594	466.97	2052.3	2519.2	467.13	2226.0	2693.1	1.4337	5.7894	7.2231
175	116.04	0.001057	1.0037	486.82	2037.7	2524.5	487.01	2213.1	2700.2	1.4850	5.6865	7.1716
200	120.21	0.001061	0.88578	504.50	2024.6	2529.1	504.71	2201.6	2706.3	1.5302	5.5968	7.1270
225	123.97	0.001064	0.79329	520.47	2012.7	2533.2	520.71	2191.0	2711.7	1.5706	5.5171	7.0877
250	127.41	0.001067	0.71873	535.08	2001.8	2536.8	535.35	2181.2	2716.5	1.6072	5.4453	7.0525
275	130.58	0.001070	0.65732	548.57	1991.6	2540.1	548.86	2172.0	2720.9	1.6408	5.3800	7.0207

Saturated water—Pressure table (*Concluded*)

		Specific volume, m³/kg		Internal energy, kJ/kg			Enthalpy, kJ/kg			Entropy, kJ/kg · K		
Press., P kPa	Sat. temp., T_{sat} °C	Sat. liquid, v_f	Sat. vapor, v_g	Sat. liquid, u_f	Evap., u_{fg}	Sat. vapor, u_g	Sat. liquid, h_f	Evap., h_{fg}	Sat. vapor, h_g	Sat. liquid, s_f	Evap., s_{fg}	Sat. vapor, s_g
800	170.41	0.001115	0.24035	719.97	1856.1	2576.0	720.87	2047.5	2768.3	2.0457	4.6160	6.6616
850	172.94	0.001118	0.22690	731.00	1846.9	2577.9	731.95	2038.8	2770.8	2.0705	4.5705	6.6409
900	175.35	0.001121	0.21489	741.55	1838.1	2579.6	742.56	2030.5	2773.0	2.0941	4.5273	6.6213
950	177.66	0.001124	0.20411	751.67	1829.6	2581.3	752.74	2022.4	2775.2	2.1166	4.4862	6.6027
1000	179.88	0.001127	0.19436	761.39	1821.4	2582.8	762.51	2014.6	2777.1	2.1381	4.4470	6.5850
1100	184.06	0.001133	0.17745	779.78	1805.7	2585.5	781.03	1999.6	2780.7	2.1785	4.3735	6.5520
1200	187.96	0.001138	0.16326	796.96	1790.9	2587.8	798.33	1985.4	2783.8	2.2159	4.3058	6.5217
1300	191.60	0.001144	0.15119	813.10	1776.8	2589.9	814.59	1971.9	2786.5	2.2508	4.2428	6.4936
1400	195.04	0.001149	0.14078	828.35	1763.4	2591.8	829.96	1958.9	2788.9	2.2835	4.1840	6.4675
1500	198.29	0.001154	0.13171	842.82	1750.6	2593.4	844.55	1946.4	2791.0	2.3143	4.1287	6.4430

Superheated water (*Continued*)

T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K
	P = 1.00 MPa (179.88°C)				P = 1.20 MPa (187.96°C)				P = 1.40 MPa (195.04°C)			
Sat.	0.19437	2582.8	2777.1	6.5850	0.16326	2587.8	2783.8	6.5217	0.14078	2591.8	2788.9	6.4675
200	0.20602	2622.3	2828.3	6.6956	0.16934	2612.9	2816.1	6.5909	0.14303	2602.7	2803.0	6.4975
250	0.23275	2710.4	2943.1	6.9265	0.19241	2704.7	2935.6	6.8313	0.16356	2698.9	2927.9	6.7488
300	0.25799	2793.7	3051.6	7.1246	0.21386	2789.7	3046.3	7.0335	0.18233	2785.7	3040.9	6.9553
350	0.28250	2875.7	3158.2	7.3029	0.23455	2872.7	3154.2	7.2139	0.20029	2869.7	3150.1	7.1379
400	0.30661	2957.9	3264.5	7.4670	0.25482	2955.5	3261.3	7.3793	0.21782	2953.1	3258.1	7.3046
500	0.35411	3125.0	3479.1	7.7642	0.29464	3123.4	3477.0	7.6779	0.25216	3121.8	3474.8	7.6047
600	0.40111	3297.5	3698.6	8.0311	0.33395	3296.3	3697.0	7.9456	0.28597	3295.1	3695.5	7.8730
700	0.44783	3476.3	3924.1	8.2755	0.37297	3475.3	3922.9	8.1904	0.31951	3474.4	3921.7	8.1183
800	0.49438	3661.7	4156.1	8.5024	0.41184	3661.0	4155.2	8.4176	0.35288	3660.3	4154.3	8.3458
900	0.54083	3853.9	4394.8	8.7150	0.45059	3853.3	4394.0	8.6303	0.38614	3852.7	4393.3	8.5587
1000	0.58721	4052.7	4640.0	8.9155	0.48928	4052.2	4639.4	8.8310	0.41933	4051.7	4638.8	8.7595
1100	0.63354	4257.9	4891.4	9.1057	0.52792	4257.5	4891.0	9.0212	0.45247	4257.0	4890.5	8.9497
1200	0.67983	4469.0	5148.9	9.2866	0.56652	4468.7	5148.5	9.2022	0.48558	4468.3	5148.1	9.1308
1300	0.72610	4685.8	5411.9	9.4593	0.60509	4685.5	5411.6	9.3750	0.51866	4685.1	5411.3	9.3036

Superheated water (*Continued*)

T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K
	P = 4.0 MPa (250.35°C)				P = 4.5 MPa (257.44°C)				P = 5.0 MPa (263.94°C)			
Sat.	0.04978	2601.7	2800.8	6.0696	0.04406	2599.7	2798.0	6.0198	0.03945	2597.0	2794.2	5.9737
275	0.05461	2668.9	2887.3	6.2312	0.04733	2651.4	2864.4	6.1429	0.04144	2632.3	2839.5	6.0571
300	0.05887	2726.2	2961.7	6.3639	0.05138	2713.0	2944.2	6.2854	0.04535	2699.0	2925.7	6.2111
350	0.06647	2827.4	3093.3	6.5843	0.05842	2818.6	3081.5	6.5153	0.05197	2809.5	3069.3	6.4516
400	0.07343	2920.8	3214.5	6.7714	0.06477	2914.2	3205.7	6.7071	0.05784	2907.5	3196.7	6.6483
450	0.08004	3011.0	3331.2	6.9386	0.07076	3005.8	3324.2	6.8770	0.06332	3000.6	3317.2	6.8210
500	0.08644	3100.3	3446.0	7.0922	0.07652	3096.0	3440.4	7.0323	0.06858	3091.8	3434.7	6.9781
600	0.09886	3279.4	3674.9	7.3706	0.08766	3276.4	3670.9	7.3127	0.07870	3273.3	3666.9	7.2605
700	0.11098	3462.4	3906.3	7.6214	0.09850	3460.0	3903.3	7.5647	0.08852	3457.7	3900.3	7.5136
800	0.12292	3650.6	4142.3	7.8523	0.10916	3648.8	4140.0	7.7962	0.09816	3646.9	4137.7	7.7458
900	0.13476	3844.8	4383.9	8.0675	0.11972	3843.3	4382.1	8.0118	0.10769	3841.8	4380.2	7.9619
1000	0.14653	4045.1	4631.2	8.2698	0.13020	4043.9	4629.8	8.2144	0.11715	4042.6	4628.3	8.1648
1100	0.15824	4251.4	4884.4	8.4612	0.14064	4250.4	4883.2	8.4060	0.12655	4249.3	4882.1	8.3566
1200	0.16992	4463.5	5143.2	8.6430	0.15103	4462.6	5142.2	8.5880	0.13592	4461.6	5141.3	8.5388
1300	0.18157	4680.9	5407.2	8.8164	0.16140	4680.1	5406.5	8.7616	0.14527	4679.3	5405.7	8.7124

L-2/T-2/EEE **Date : 16/01/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2012-2013

Sub : **MATH 357** (Probability and Statistics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **TRHEE**.

1. (a) Find median, third quartile, second decile, seventy percentile from the table. Draw a suitable diagram and locate them. **(17)**

Age (years)	Under 25	25-29	30-34	35-44	45-54	55-64	65-74	Above 74
Number (million)	2.3	4.1	5.3	10.6	9.7	6.8	4.4	1.8

(b) For a symmetric and mesokurtic distribution of 200 heights, given that mean and SD are 40 and 15. It was however discovered that 2 items 43 and 35 were wrongly written in place of correct values 34 and 53 respectively. Calculate corrected mean, standard deviation, β_1 and β_2. Represent them graphically with your comments. Also find coefficient of variation. **(18)**

2. (a) The probability that the head of household is at home when a telemarketing representative calls is 0.4. Given that the head of a household is at home, the probability that goods will be bought from the company is 0.3. Find the probability that the head of a household is at home and goods being bought from the company. **(15)**

(b) An investment consultant predicts that the odds against the price of a certain stock will go up during the next week are 2:1 and the odds in favor of the price remaining the same are 1 : 3. What is the probability that the price of the stock will go down during the next week? **(15)**

(c) Prove that the covariance of random variables X and Y with means μ_x and μ_y, respectively, is $\sigma_{XY} = E(XY) - \mu_X\mu_Y$. **(5)**

3. (a) An important system acts in support of a vehicle in our space program. A single crucial component works only 85% of time. In order to enhance reliability of the system, it is decided that 3 components will be installed in parallel such that the system fails only if they all fail. Assume they act independently and they are equivalent in the sense that all 3 of them have 85% success rate. Random variable X denotes number of components out of 3 that fail. What is the probability that the system fails? **(15)**

(b) State Chebyshev's theorem and use it to find $p(|X-10|<3)$ where X is a random variable having mean 10 and variance 4. **(5)**

Contd P/2

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Contd … Q. No. 3

(c) A coin is tossed twice. Let Z denotes the no. of heads on the first toss and W the total number of heads on the 2 tosses. If the coin is unbalanced and a head has a 40% chance of occurring, find the joint probability mass function of W and Z as well as their marginal distributions. **(15)**

4. (a) Find mean and variance of Binomial distribution. When does this distribution tend to Bernoulli distribution? **(10)**

(b) A certain machine makes electrical resistors having a mean resistance of 40 ohms and a standard deviation of 2 ohms. What percentage of resistors will have a resistance exceeding 43 ohms? Also find the percentage of resistors exceeding 43 ohms if resistance is measured to the nearest ohm. **(10)**

(c) Based on extensive testing it is determined that the time Y in years before a major repair is required for a certain washing machine is characterized by the density function

$$f(y)=\begin{cases}\frac{1}{4}e^{-y/4}, & y\geq 0\\ 0, & \text{elsewhere}\end{cases}$$

. Note that it is an exponential with mean 4 years. The machine is considered a bargain if it is unlikely to require a major repair before the sixth year. Thus, what is the probability $P(Y>6)$? Is the machine really a bargain? Also, what is the probability that a major repair occurs in the first year? **(15)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) The following table gives the weight of 100 students. Show how to select 20 random samples of 4 students each (with replacement) from the given table by using random numbers. (Table attached) **(17)**

Weight (kg)	Frequency
40-42	6
43-45	17
46-48	43
49-51	25
52-54	9

(b) Find the mean and the standard deviation of the sampling distribution of means in part (a). **(9)**

(c) Compare the results of part (b) with theoretical values, explaining any discrepancies. **(9)**

Contd ………. P/3

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6. (a) Prove that the coefficient of correlation lies between – 1 and + 1. Calculate the coefficient of correlation from the following data and comment on the result. **(17)**

x:	2135	2547	2364	2293	2161
y:	76	88	82	79	75

(b) Find the regression line of y on x and x on y from the following data

x:	5	7	12	17	27	28	31
y:	37	36	49	51	65	61	66

Also obtain the correlation coefficient form the two regression coefficients. **(18)**

7. (a) On a examination given to students at a large number of different schools, the mean grade was 74.5 and the standard deviation was 8. At one particular school where 200 students took the examination, the mean grade was 75.9. Discuss the significance of this result at the 0.01 level from the viewpoint of (i) a one-tailed test and (ii) a two-tailed test (Table attached)

(b) Explain the terms level of significance and degrees of freedom. A bulb manufacturing company claims that the average longevity of their bulb is 4 years with a standard deviation 0.16 years. A random sample of 10 bulbs gave mean longevity of 3.45 years. Does the sample mean justify the claim of the manufacture? Use a 5 percent level of significance. (Table attached)

8. (a) At an agriculture station it was desired to test the effect of a given fertilizer on rice production. To accomplish this, 24 plots of land having equal areas are chosen. Half of these were treated with fertilizer and the other half were untreated, the other conditions were the same. The mean yield of rice on the untreated plots was 4.8 kg with a standard were the same. The mean yield of rice on the untreated plots was 4.8 kg with a standard deviation of 0.4 kg. While the mean yield on the treated plots was 5.1 kg with a Standard deviation of 0.36 kg. Can we conclude at significance level of 5% that there is a significant improvement in rice production because of the fertilizer? (Table attached) **(15)**

(b) A company wishes to purchase one of five different machines: A, B, C, D or E. In an experiment designed to test whether there is a difference in the machines' performance, each of five experienced operators works on each of the machines for equal times. Table below shows the number of units produced per machine. Test the hypothesis that there is no difference between the machines at significance level of 0.05. (Table attached) **(20)**

A	68	72	77	42	53
B	72	53	63	53	48
C	60	82	64	75	72
D	48	61	57	64	50
E	64	65	70	68	53

Table A.3 (continued) Areas under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Table for question no. 4(b)

Appendix IX

Random Numbers

51772	74640	42331	29044	46621	62898	93582	04186	19640	87056
24033	23491	83587	06568	21960	21387	76105	16863	97453	90581
45939	60173	52078	25424	11645	55870	56974	37428	93507	94271
30586	02133	75797	45406	31041	86707	12973	17169	88116	42187
03585	79353	81938	82322	96799	85659	36081	50884	14070	74950
64937	03355	95863	20790	65304	55189	00745	65253	11822	15804
15630	64759	51135	98527	62586	41889	25439	88036	24034	67283
09448	56301	57683	30277	94623	85418	68829	06652	41982	49159
21631	91157	77331	60710	52290	16835	48653	71590	16159	14676
91097	17480	29414	06829	87843	28195	27279	47152	35683	47280
50532	25496	95652	42457	73547	76552	50020	24819	52984	76168
07136	40876	79971	54195	25708	51817	36732	72484	94923	75936
27989	64728	10744	08396	56242	90985	28868	99431	50995	20507
85184	73949	36601	46253	00477	25234	09908	36574	72139	70185
54398	21154	97810	36764	32869	11785	55261	59009	38714	38723
65544	34371	09591	07839	58892	92843	72828	91341	84821	63886
08263	65952	85762	64236	39238	18776	84303	99247	46149	03229
39817	67906	48236	16057	81812	15815	63700	85915	19219	45943
62257	04077	79443	95203	02479	30763	92486	54083	23631	05825
53298	90276	62545	21944	16530	03878	07516	95715	02526	33537

Table for Q. No. 5(a)

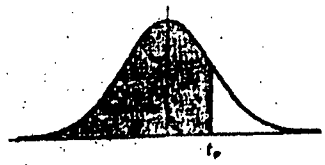
Table 10.1

Level of significance, α	0.10	0.05	0.01	0.005	0.002
Critical values of z for one-tailed tests	−1.28 or 1.28	−1.645 or 1.645	−2.33 or 2.33	−2.58 or 2.58	−2.88 or 2.88
Critical values of z for two-tailed tests	−1.645 and 1.645	−1.96 and 1.96	−2.58 and 2.58	−2.81 and 2.81	−3.08 and 3.08

Table for Q. No 7(a)

Appendix III

Percentile Values (t_p)
for
Student's t Distribution
with ν Degrees of Freedom
(shaded area = p)



ν	$t_{.995}$	$t_{.99}$	$t_{.975}$	$t_{.95}$	$t_{.90}$	$t_{.80}$	$t_{.75}$	$t_{.70}$	$t_{.60}$	$t_{.55}$
1	63.66	31.82	12.71	6.31	3.08	1.376	1.000	.727	.325	.158
2	9.92	6.96	4.30	2.92	1.89	1.061	.816	.617	.289	.142
3	5.84	4.54	3.18	2.35	1.64	.978	.765	.584	.277	.137
4	4.60	3.75	2.78	2.13	1.53	.941	.741	.569	.271	.134
5	4.03	3.36	2.57	2.02	1.48	.920	.727	.559	.267	.132
6	3.71	3.14	2.45	1.94	1.44	.906	.718	.553	.265	.131
7	3.50	3.00	2.36	1.90	1.42	.896	.711	.549	.263	.130
8	3.36	2.90	2.31	1.86	1.40	.889	.706	.546	.262	.130
9	3.25	2.82	2.26	1.83	1.38	.883	.703	.543	.261	.129
10	3.17	2.76	2.23	1.81	1.37	.879	.700	.542	.260	.129
11	3.11	2.72	2.20	1.80	1.36	.876	.697	.540	.260	.129
12	3.06	2.68	2.18	1.78	1.36	.873	.695	.539	.259	.128
13	3.01	2.65	2.16	1.77	1.35	.870	.694	.538	.259	.128
14	2.98	2.62	2.14	1.76	1.34	.868	.692	.537	.258	.128
15	2.95	2.60	2.13	1.75	1.34	.866	.691	.536	.258	.128
16	2.92	2.58	2.12	1.75	1.34	.865	.690	.535	.258	.128
17	2.90	2.57	2.11	1.74	1.33	.863	.689	.534	.257	.128
18	2.88	2.55	2.10	1.73	1.33	.862	.688	.534	.257	.127
19	2.86	2.54	2.09	1.73	1.33	.861	.688	.533	.257	.127
20	2.84	2.53	2.09	1.72	1.32	.860	.687	.533	.257	.127
21	2.83	2.52	2.08	1.72	1.32	.859	.686	.532	.257	.127
22	2.82	2.51	2.07	1.72	1.32	.858	.686	.532	.256	.127
23	2.81	2.50	2.07	1.71	1.32	.858	.685	.532	.256	.127
24	2.80	2.49	2.06	1.71	1.32	.857	.685	.531	.256	.127
25	2.79	2.48	2.06	1.71	1.32	.856	.684	.531	.256	.127
26	2.78	2.48	2.06	1.71	1.32	.856	.684	.531	.256	.127
27	2.77	2.47	2.05	1.70	1.31	.855	.684	.531	.256	.127
28	2.76	2.47	2.05	1.70	1.31	.855	.683	.530	.256	.127
29	2.76	2.46	2.04	1.70	1.31	.854	.683	.530	.256	.127
30	2.75	2.46	2.04	1.70	1.31	.854	.683	.530	.256	.127
40	2.70	2.42	2.02	1.68	1.30	.851	.681	.529	.255	.126
60	2.66	2.39	2.00	1.67	1.30	.848	.679	.527	.254	.126
120	2.62	2.36	1.98	1.66	1.29	.845	.677	.526	.254	.126
∞	2.58	2.33	1.96	1.645	1.28	.842	.674	.524	.253	.126

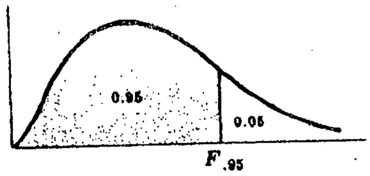
Source: R. A. Fisher and F. Yates, *Statistical Tables for Biological, Agricultural and Medical Research* (5th edition), Table III, Oliver and Boyd Ltd., Edinburgh, by permission of the authors and publishers.

Table for Q No 7(b) and 8(a)

ndix V

95th Percentile Values for the F Distribution

(ν_1 degrees of freedom in numerator)
(ν_2 degrees of freedom in denominator)



ν_2 \ ν_1	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161	200	216	225	230	234	237	239	241	242	244	246	248	249	250	251	252	253	254
2	18.5	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.5	19.5	19.5	19.5	19.5	19.5
3	10.1	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.37
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

Source: E. S. Pearson and H. O. Hartley, *Biometrika Tables for Statisticians*, Vol. 2 (1972), Table 5, page 178, by permission.

Table for Q. No 8(b)

L-2/T-2/EEE **Date : 15/12/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B.Sc. Engineering Examinations 2012-2013

Sub : **EEE 207** (Electronics - II)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

Symbols have their usual meanings.

1. (a) Write down the characteristics of an ideal op-Amp. Briefly explain the "virtual ground" concept of OP-AMP. **(8)**

(b) Determine the expression of closed-loop voltage gain under the ideal OP-AMP assumption for the amplifier of Fig. for Q. 1(b). **(15)**

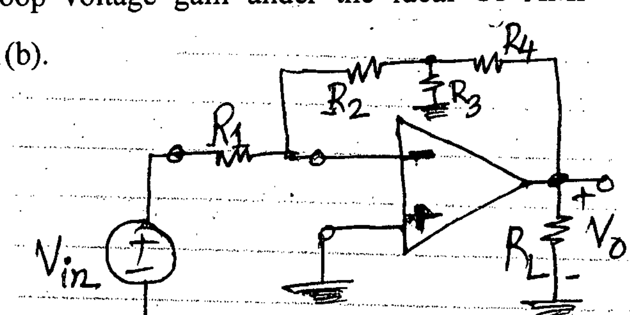


Fig. for Q. 1(b)

(c) Define slow rate in connection with OP-AMP. For the amplifier circuit shown in Fig. for Q. 1(c), determine whether the output voltage will be distorted or not. Given that the slow rate of OP-AMP is 0.4 V/μs. **(12)**

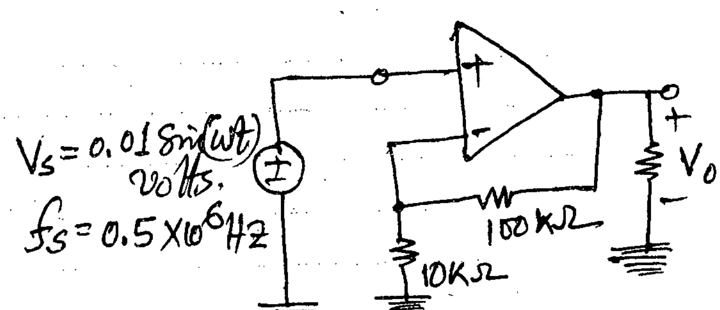
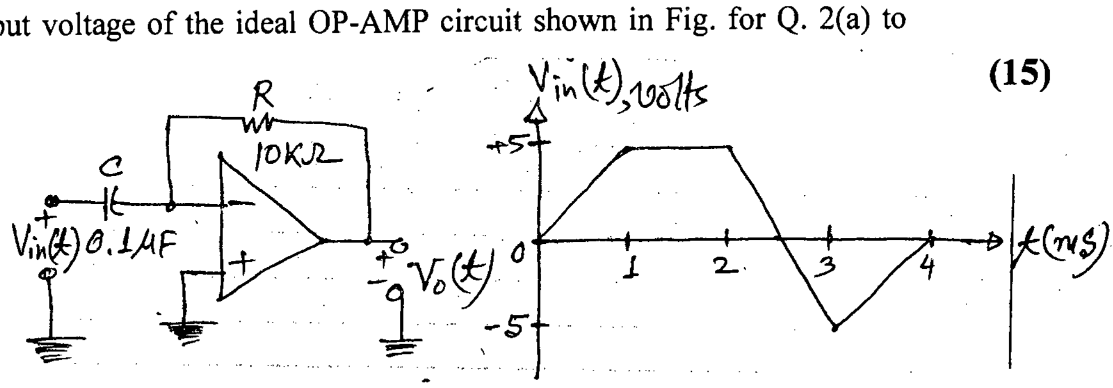


Fig. for Q. 1(c)

2. (a) Sketch the output voltage of the ideal OP-AMP circuit shown in Fig. for Q. 2(a) to scale against time. **(15)**

Fig. for Q. No. 2(a)



(b) Explain the operation of a smoke detector with neat sketches. **(10)**

Contd P/2

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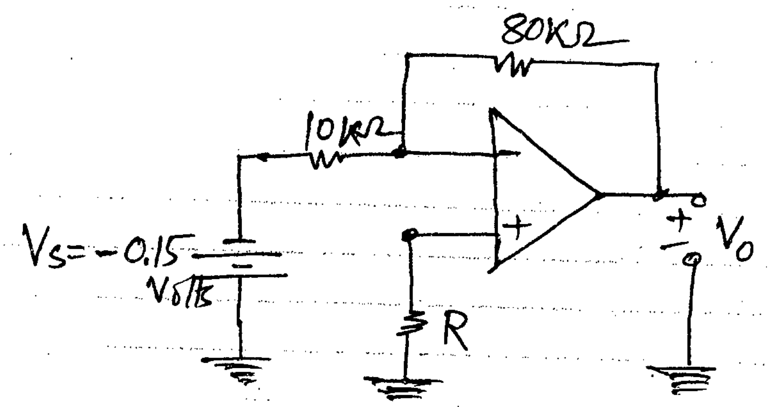
Contd ... Q. No. 2

(c) Write down the characteristics of an OP-AMP those add error components to the DC output voltage. Refer to Fig. for Q. 2(c), V_{io} = 2 mV, I_{B-} = 0.3 μA, and I_{B+} = 0.1 μA (i) What is the best value of R if the source resistance is 10 Ω? Calculate the individual error in the output voltage due to (ii) V_{io} only; (iii) I_{os} only. (iv) What is the actual value of output voltage when both input offset voltage and current are present along with V_s? **(10)**

Fig. for Q. No. 2(c)



3. (a) Establish the Barkhausen criteria for sinusoidal oscillators. Briefly explain why it is necessary to maintain the magnitude of loop gain that is $|\beta A| > 1.0$ for the design of sinusoidal oscillators. **(10)**

(b) Draw the circuit diagram of a C - R phase-shift oscillator and explain how Barkhausen criteria are satisfied in this circuit. **(10)**

(c) Design the Colpits Oscillator to produce a 40 kHz output frequency with an amplitude of ±9 V. Use a 100 mH inducts and make necessary assumptions. **(15)**

4. (a) Derive the expression of equivalent reactance of a crystal used in crystal oscillators. Also draw the reactance versus frequency curve of the crystal. **(10)**

(b) Derive the expression of cut-off frequency for a +40 dB/decade high-pass Butter worth filter. **(15)**

(c) Design a +40 dB/decade high pass Butterworth filter for a cutoff frequency of 5 k rad/sec. Assume $C_1 = C_2 = 0.02$ μF. Also, draw the frequency response curve (including Bode plot) of the designed filter. **(10)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Prove quantitatively that negative feedback in which the feedback signal is returned to the input in shunt with the applied signal, regardless of whether the feedback is obtained by sampling the output current or voltage, decreases the input resistance. (Show proofs for voltage-shunt and current-shunt feedback, separately.) **(18)**

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Contd ... Q. No. 5

(b) The circuit of Fig. for Q. 5(b) has the following parameters: $R_c = 4$ k, $R' = 40$ k, $R_s =$ 10 k, $h_{ie} = 1.1$ k, $h_{fc} = 50$, and $h_{re} = h_{oe} = 0$.

Find (i) A_{vf}, (ii) R_{if}, and (iii) R'_{of}. **(17)**

6. (a) Classify amplifiers into four broad categories. For each of them prove, separately, that the output signal is directly proportional to the input signal and the proportionality constant does not depend on source or load resistance. **(16)**

(b) Using schematic representation of a single loop feedback amplifier, show that the transfer gain of the amplifier with feedback can be given as, **(8)**

$$A_f = \frac{A}{1+\beta A}$$

where, symbols have their usual meaning.

(c) Briefly explain that the non-linear distortion in an amplifier output is greatly reduced when negative feedback is employed. **(11)**

7. (a) Sketch Bode plot for the magnitude of the following transfer function,

$$T(s) = \frac{10^9 s^2 (s+10^4)}{(s+10)(s+100)^2(s+10^6)}$$

From your sketch, determine approximate value of magnitude at $\omega = 10^6$ rad/s. (Use graph paper if necessary.) **(10+2+3+1)**

What is the exact value of magnitude at $\omega = 10^6$ rad/s? Calculate percentage error in the approximate value you determined from the Bode plot.

(b) Assume that the high frequency response of an amplifier is given by,

$$F_H(s) = \frac{(1+s/\omega_{z1})(1+s/\omega_{z2})\cdots(1+s/\omega_{znH})}{(1+s/\omega_{p1})(1+s/\omega_{p2})\cdots(1+s/\omega_{pnH})}$$

where, symbols have their usual meaning. Then derive the approximate equation for the upper cut-off frequency ω_H. Also, show that this equation is valid even if the 'dominant pole situation' exists. **(10)**

(c) Show that the upper 3-dB frequency of an amplifier, whose poles and zeros connot be easily determined, can be approximately given as, **(9)**

$$\omega_H = \left[\sum_{i=1}^{nH} C_i R_{io}\right]^{-1}$$

where, symbols have their usual meaning.

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8. (a) Showing load line and Q point, briefly describe the operation, merits and demerits of a class-B power amplifier. **(10)**

(b) For class-A operation of an amplifier prove that, **(8)**

$$I_{CQ} = \frac{V_{cc}}{R_{dc} + R_{ac}}$$

where, symbols have their usual meaning.

(c) With necessary diagram prove that the maximum conversion efficiency of a transformer coupled class-A amplifier is 50%. **(8)**

(d) Derive the equation for power rating of each transistor used in a class-B push-pull amplifier. **(9)**

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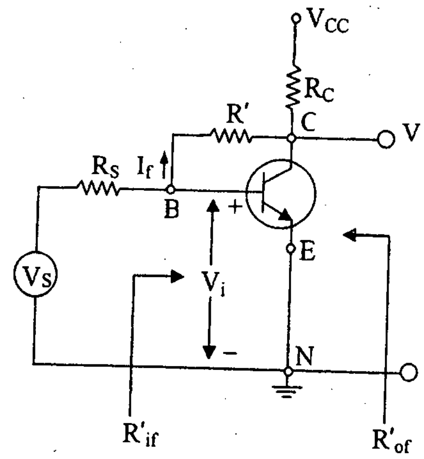

Fig. for Q. 5(b)