L-2/T-1/CHE **Date : 26/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **MATH 221** (Vector Analysis, Matrices and Laplace Transforms)

Full Marks: 280 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

Symbols used have their usual meaning.

1. (a) If $\underline{a}$, $\underline{b}$, $\underline{c}$ are three non-zero non-coplanar vectors. Find a linear relation between the following vectors: **(20)**

$$\underline{a}-\underline{b}+\underline{c}, \quad \underline{b}+\underline{c}-\underline{a}, \quad \underline{c}+\underline{a}+\underline{b}, \quad 2\underline{a}-3\underline{b}+4\underline{c}$$

(b) In a trapezium, the mid-point of one of the non-parallel sides is joined to the extremities of the opposite side. Show that the area of the triangle so formed is half of the trapezium. **(16⅔)**

(c) If $[\underline{a}\ \underline{b}\ \underline{p}] = 0$ and $\underline{a} \times \underline{b} \neq \underline{0}$, express $\underline{p}$ in terms of $\underline{a}$ and $\underline{b}$. **(10)**

2. (a) A particle moves along the curve $x = 2t^2$, $y = t^2 - 4t$, $z = 3t - 5$. Find the components of its velocity and acceleration at time $t = 1$ in the direction $\underline{i} - 3\underline{j} + 2\underline{k}$. **(10)**

(b) Find the equation of the osculating plane at any point t on the curve given by $x = 2\ln t$, $y = 4t$, $z = 2t^2 + 1$. **(16⅔)**

(c) Calculate the curvature and torsion of the curve $x = a\cos t$, $y = a\sin t$, $z = ct$. Is the curve a plane curve? **(20)**

3. (a) Find the value of $\nabla^2\left(\frac{x}{r^3}\right)$. **(16⅔)**

(b) Determine the constants a, b, c so that the vector **(15)**

$$\vec{F} = (x + 2y + az)\underline{i} + (bx - 3y - z)\underline{j} + (4x + cy + 2z)\underline{k}$$

is irrotational.

(c) Find the work done when a force $\vec{F} = (x^2 - y^2 + x)\underline{i} - (2xy + y)\underline{j}$ moves a particle in xy-plane from (0, 0) to (1, 1) along the parabola $y^2 = x$. **(15)**

4. (a) By converting the surface integral into a volume integral, evaluate **(26⅔)**

$\iint_S (x^3 dydz + y^3 dzdx + z^3 dxdy)$, where S is the surface of the sphere $x^2 + y^2 + z^2 = 1$.

(b) Verify Stokes theorem for $\vec{F} = (x^2 + y^2)\underline{i} - 2xy\underline{j}$ taken around the rectangle bounded by $x = \pm a$, $y = 0$, $y = b$. **(20)**

SECTION – B

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

Symbols used have their usual meaning.

5. (a) Find the adjoint of the matrix $A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & -3 \\ 2 & -1 & 3 \end{bmatrix}$ and show that $A(adj.A) = |A|.I_3$. **(13)**

Contd P/2

MATH 221/CHE

Contd... Q. No. 5

(b) Find the canonical matrix row equivalent of the following matrix: **(13⅔)**

$$A=\begin{bmatrix}1 & 2 & 3 & 4\\ 2 & 7 & 3 & 5\\ 3 & 8 & 1 & -2\end{bmatrix}.$$

(c) Using only elementary row transformations, to reduce A to I, find the inverse of the following matrix A: **(20)**

$$A=\begin{bmatrix}1 & 2 & 3 & 4\\ 2 & 3 & 4 & 6\\ 3 & 4 & 5 & 7\\ 4 & 5 & 5 & 7\end{bmatrix}.$$

6. (a) Find the characteristics equation of the matrix **(16)**

$$A=\begin{bmatrix}1 & 2 & 3\\ 2 & -1 & 1\\ 3 & 1 & 1\end{bmatrix}$$

and verify Cayley-Hamilton theorem for it. Since A is non-singular, using above compute A^{-2}.

(b) Determine the values of k such that the system in unknown x, y, and z has (i) a unique solution (ii) no solution (iii) more than one solution: **(14)**

$$kx+y+z=1$$
$$x+ky+z=1$$
$$x+y+kz=1$$

(c) Show that the quadratic form: **(16⅔)**

$q=5x_1^2+4x_2^2+15x_3^2+14x_2x_3+16x_3x_1+6x_1x_2$ is positive semi-definite and find a non-trivial set of values of x_1, x_2, x_3 which makes the form zero.

7. (a) Find $L\{f(t)\}$ if $f(t)=\begin{cases}(t-7)e^{-2(t-7)}\cos 3(t-7), t>7\\ 0, t<7\end{cases}$. **(14)**

(b) State and prove Heaviside's Expansion Formula and using this formula find $L^{-1}\left\{\dfrac{3s+1}{(s-1)(s^2+1)}\right\}$. **(16⅔)**

(c) Find (i) $L\left\{\dfrac{2}{\sqrt{\pi}}\int_0^{\sqrt{t}}e^{-u^2}du\right\}$ (ii) $L^{-1}\left\{\dfrac{1}{(s^2+2s+5)^{3/2}}\right\}$. **(16)**

8. (a) Solve the following differential equations by using Laplace transformation: **(36⅔)**

(i) $y''(t)-3y'(t)+2y(t)=2e^{-t},\ y(0)=2, y'(0)=-1$

(ii) $y''(t)-ty'(t)+y(t)=1,\ y(0)=1, y'(0)=2$

(b) Use Laplace transformation to evaluate the integral: $\int_0^{\infty}\cos x^2\,dx$. **(10)**

L-2/T-1/CHE **Date : 09/06/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **CHE 201** (Material and Energy Balance)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

A booklet containing all relevant data is supplied

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer **Q. No. 1** and any **TWO** from the rest.

Q. No. 1 is **compulsory**.

1. (a) For an air-water system, explain the concept of superheat, saturation and dew point in terms of vapor pressure and partial pressure. **(6)**

   (b) In the context of psychrometric chart, define humid volume and enthalpy deviation. **(6)**

   (c) What is *flowsheeting*? Describe briefly the role of degrees of freedom analysis in flowsheeting. **(4)**

   (d) What is heat of solution? Explain briefly. **(3)**

   (e) Humid air at 80°C, 1.1 bar and 40% relative humidity is fed into a process unit at a rate of 1000 m^3/h. Determine the dew point and the molar flow rate of water. **(7)**

   (f) Draw the phase diagram of water and label it completely. **(5)**

   (g) What is the wet bulb temperature? What is its significance? **(4)**

2. (a) A tank initially contains 10 litres of a salt solution at a concentration of 2 g/litre. Another salt solution of concentration of 1 g/litre enters the tank at a rate of 1.5 litres/min. The tank contents are well-stirred and the mixture leaves the tank at a rate of 1 litre/min. (i) Find the expression for the volume of solution in the tank, V(t), at any time t. (ii) Find the expression of salt concentration in the tank, C(t), for any time t. (iii) Estimate the time at which the concentration in the tank will be 1.6 g/litre. (iv) When will the content of the tank be 18 litres? **(18)**

   (b) A solution of sugar in water is to be concentrated from 10 wt% sugar to 25 wt% sugar. The solution is at about 45°C when it is fed continuously to a bubble column. Air at 45°C with a dew point of 4°C is bubbled through the column and emerges saturated. The humidification of the air can be considered adiabatic. How many kilograms of dry air must be fed per kilograms of the entering sugar solution? What is the corresponding volume of the entering air? Psychrometric chart is provided in Figure for Q. 2(b). **(17)**

Contd P/2

CHE 201

3. (a) Methanol is produced in the reaction of carbon dioxide and hydrogen: **(20)**

$$CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$$

The fresh feed to the process contains hydrogen, carbon dioxide and 0.40 mole percent inerts (I). The reactor effluent passes to a condenser that removes essentially all of the methanol and water formed and none of the reactants or inerts. The latter substances are recycled to the reactor. To avoid buildup of the inerts in the system, a purge stream is withdrawn from recycle. The feed to the reactor contains 28.0 mole% CO_2, 70 mole% H_2 and 2% inerts. The single pass conversion of H_2 is 60%. Perform a detailed degrees of freedom analysis for the process.

(b) n-Hexane is burned with excess air. An analysis of the product gas yields the following dry-basis molar compositions: 82.1% N_2, 6.9% CO_2, 2.1% CO, 8.6% O_2, and 0.3% C_6H_{14}. The stack gas emerges at 760 mm Hg. Calculate the percentage conversion of hexane, the percentage excess air fed to the burner, and the dew point of the stack gas, taking water to be the only condensable species. **(15)**

4. A natural gas at 35°C containing 90 mole% methane and the balance ethane is burned with 20% excess air. The stack gas, which contains no unburned hydrocarbons or carbon monoxide, leaves the furnace at 900°C and 1.2 atm and passes through a heat exchanger (See Figure for Q. 4). The air on its way to the furnace also passes through the heat exchanger, entering it at 20°C and leaving it at 250°C. **(35)**

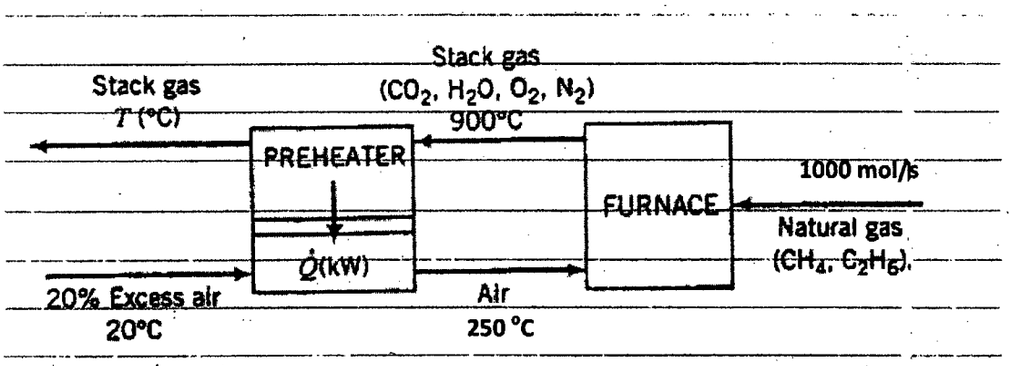


Figure for Q. 4

Taking as a basis of 1000 mol/s of the natural gas fed to the furnace, calculate the composition of the stack gas, the required rate of heat transfer in the preheater and the temperature at which the stack gas leaves the preheater.

Contd P/3

CHE 201

SECTION – B

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

5. Benzene is to be produced from toluene ($C_6H_5CH_3$) according to the reaction: **(35)**

$$C_6H_5CH_3 + H_2 \rightarrow C_6H_6 + CH_4$$

Some of the benzene formed undergoes a side reaction to produce an unwanted byproduct: diphenyl, and hydrogen.

$$2C_6H_6 \rightarrow C_{12}H_{10} + H_2$$

Diphenyl

See figure for Question 5. Hydrogen-toluene of 5 is maintained at the REACTOR's inlet. The selectivity (ratio of benzene formed to toluene reacted) is related to the conversion (ratio of toluene reacted to toluene fed) according to:

$$S = 1 - \frac{0.0036}{(1-X)^{1.544}}$$ where S = selectivity and X = conversion.

The reactor outlet is thus likely to contain hydrogen, methane, benzene, toluene and diphenyl.

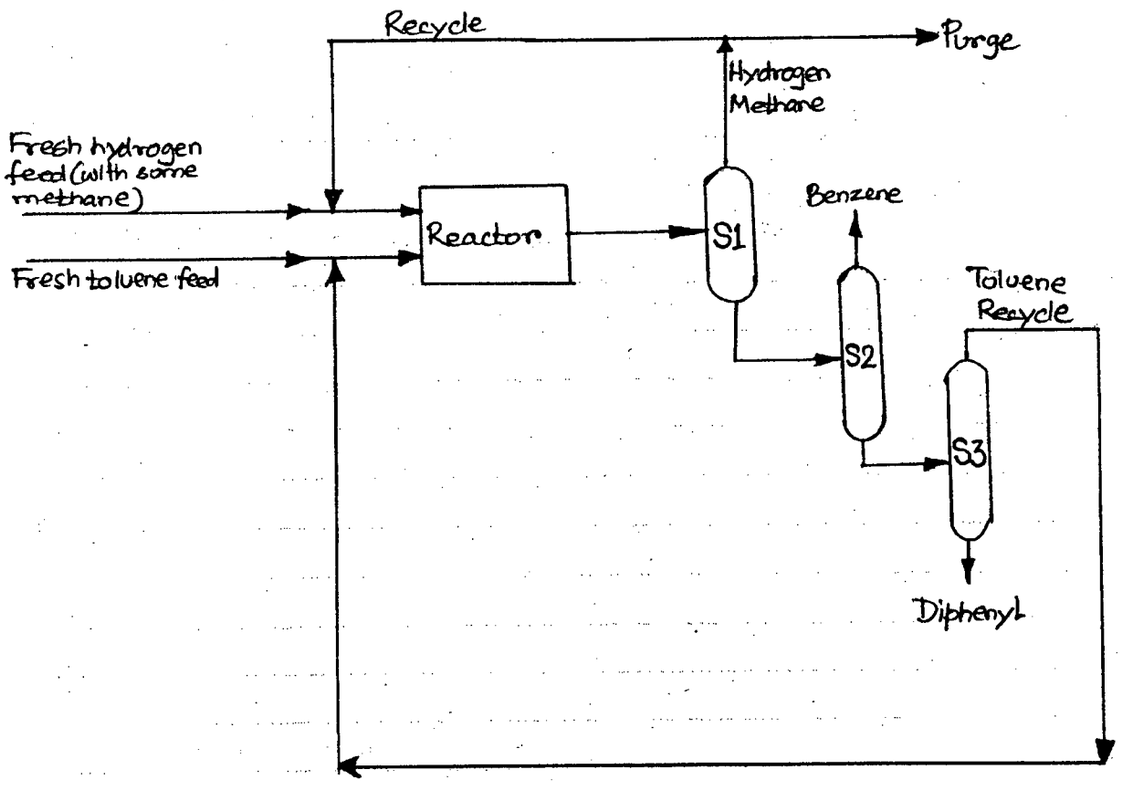


Figure for Question 5.

CHE 201

Contd... Q. No. 5

The gases hydrogen and methane from the reactor are all separated from the liquid containing benzene, toluene and diphenyl in separator S1. Separator S2 separates all benzene. Rate of production of benzene is 265 kmol/hr from S2. S3 separates all the diphenyl from toluene. The toluene is recycled.

The fresh hydrogen contains methane as impurity at a mole fraction of 0.05. Methane is also produced as a byproduct and needs to be purged along with some hydrogen.

For conversion (X) of 0.75 in the reactor, and mole fraction of methane in the purge being 0.4, find the composition of the reactor effluent.

6. Methane is burned with 30% excess air in a continuous adiabatic reactor. The methane enters the reactor at 25°C and 1.10 atm at a rate of 5.50 L/s and the entering air is at 150°C and 1.10 atm. Combustion in the reactor is complete and the reactor effluent gas emerges at 1.05 atm. Calculate

   (i) the temperature

   (ii) the degrees of superheat of the reactor effluent.

   (Consider water to be the only condensable species in the effluent) **(27+8)**

7. (a) A natural gas is analyzed and found to consist of 85% v/v methane, 10% ethane, 2% propane and 3% N_2 (noncombustible). Calculate the higher heating value and the lower heating value of this fuel in kJ/mol. **(15)**

   (b) Methanol vapor is burnt with excess air in a catalytic combustion chamber. Liquid methanol, initially at 25°C is vaporized at 1.1 atm and heated to 100°C; the vapor is mixed with air that has been preheated to 100°C, and the combined stream is fed to the reactor at 100°C and 1 atm. The reactor effluent emerges at 300 °C and 1 atm. Analysis of the product gas yields a dry-basis composition of 4.5% CO_2, 14.5% O_2 and 81% N_2. Taking a basis of 1 g-mole of methanol burned, calculate the heat (kJ) needed to vaporize and heat the methanol feed, and the heat (kJ) that must be transferred from the reactor. **(20)**

8. (a) A mixture of 75 mole% propane and 25 mole% hydrogen is burned with 25% excess air. Fractional conversions of 90% of the propane and 85% of the hydrogen are achieved; of the propane that reacts, 90% reacts to form CO_2 and the balance reacts to form CO. The hot combustion product gas passes through a boiler in which heat transferred from the gas converts boiler feedwater into steam. Calculate the concentration of CO (ppm) in the stack gas. **(15)**

Contd P/5

CHE 201

Contd... Q. No. 8

(b) In the production of a bean oil, beans containing 15 wt% oil and 85 wt% solid are, ground and fed to a stirred tank (the extractor) along with a recycled stream of liquid n-hexane. The feed ratio is 3 kg of hexane/kg of beans. The ground beans are suspended in the liquid and essentially all of the oil in the beans is extracted into the hexane. The extractor effluent passes to a filter. The filter cake contains 75.0 wt% bean solids and the balance bean oil and hexane, the latter two in the same ratio in which they emerge from the extractor. The filter cake is discarded and the liquid filtrate is fed to a heated evaporator where the hexane is vaporized and the oil remains as liquid. This oil is then stored and sold. The hexane vapor is condensed and recycled to the extractor in liquid form. **(20)**

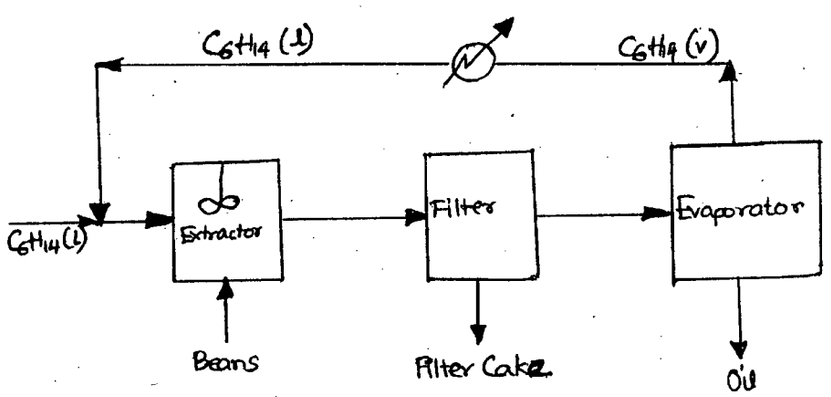


Figure for Question 8b.

Calculate the yield of bean oil product (kg oil/kg beans fed), the required fresh hexane feed (kg C_6H_{14}/kg beans fed) and the recycle to fresh feed ratio.

Contd....P/

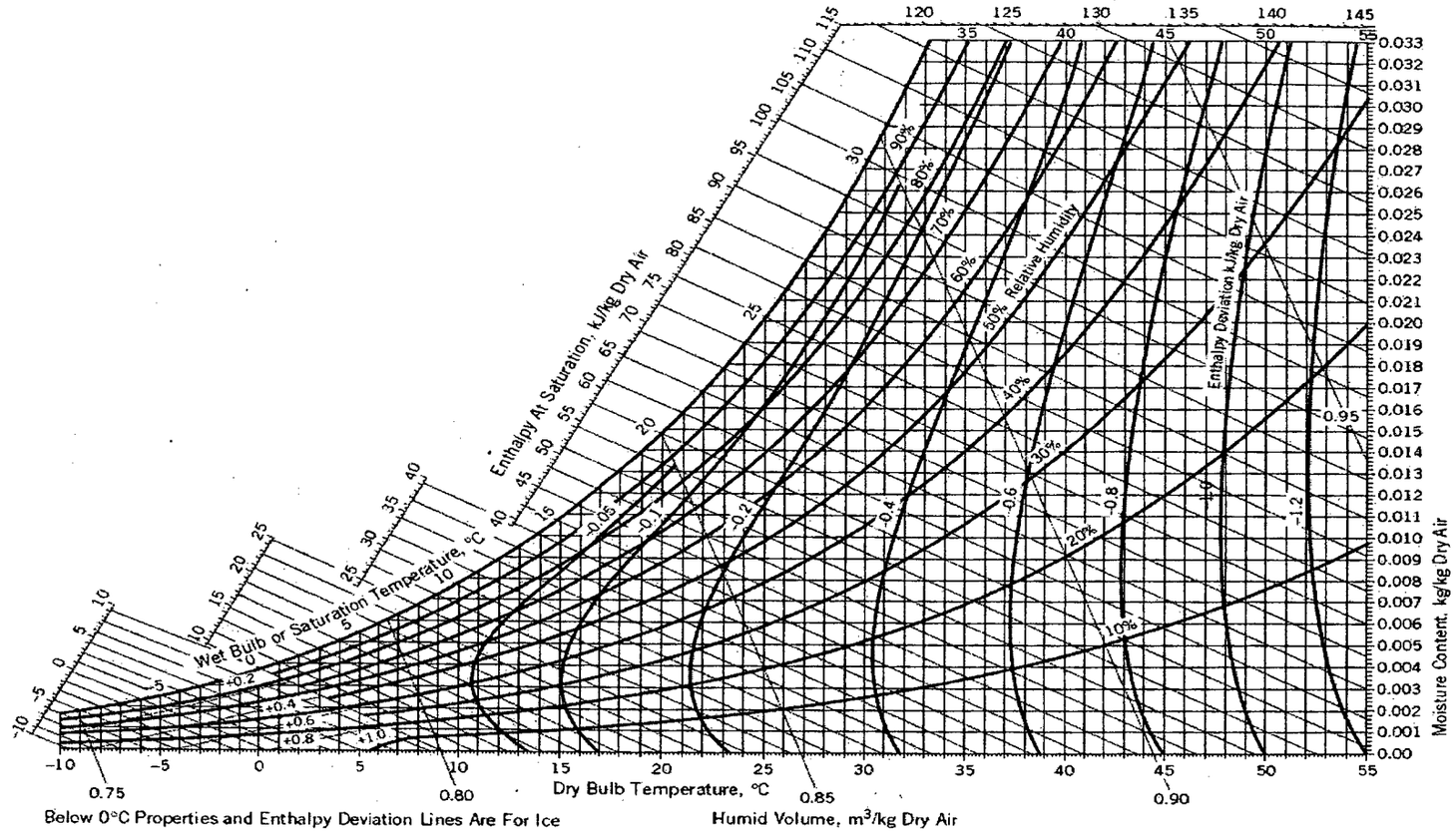


Figure 8.4-1 Psychrometric chart—SI units. Reference states: H_2O (L, 0°C, 1 atm), dry air (0°C, 1 atm). (Reprinted with permission of Carrier Corporation.)

Figure for Q 2(b)

L-2/T-1/CHE **Date : 12/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **CHE 203** (Chemical Engineering Thermodynamics-I)

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**.

1. (a) Starting from basic definition show that **(12)**

$$\Delta S = \int_{T_1}^{T_2} \frac{Cv}{T} dT + \int_{v_1}^{v_2} \left(\frac{\delta P}{\delta T}\right)_v dv$$

(b) Derive the Clapeyron-Clausius equation. What is the main use of this equation in thermodynamics? **(13)**

(c) Write a short note on Joule-Thomson co-efficient (include inversion temperature and related terms in your answer). **(10)**

2. (a) What are the indealizations and simplifications commonly employed in analyzing power cycles? What are the "Cold-air-Standard" assumptions? **(8)**

(b) Derive the expression for thermal efficiency of air-standard Otto cycle in terms of compression ratio. **(12)**

(c) Show that the thermal efficiency of air-standard Otto cycle increases with compression ratio. **(5)**

(d) What are the difficulties to achieve higher compression ratio in actual Otto engines? **(10)**

3. (a) Thermal efficiencies of simple steam power plants are around 40%. Where goes the other 60% of the supplied heat? Explain the factors that prevent from achieving higher efficiency. **(2+8)**

(b) Discuss the different ways of improving the efficiency of the simple power plant. Use T-S diagrams to elaborate your answer. **(15)**

(c) What is cogeneration? Draw the schematics of a typical cogeneration plant. **(10)**

4. (a) Steam enters an adiabatic turbine at 6 MPa, 650°C, and 80 m/s and leaves at 50 kPa, 100°C, and 140 m/s . If the power output of the turbine is 5 MW, determine the second law efficiency of the turbine. Assume the surroundings to be at 30°C. **(15)**

(b) Describe the working of a gas refrigeration cycle with schematics and thermodynamic diagrams. **(12)**

(c) What is cascade refrigeration? What are the advantages and disadvantages of cascade refrigeration? **(8)**

Contd P/2

CHE 203

SECTION – B

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

STEAM TABLE IS TO BE SUPPLIED.

5. (a) Distinguish between the concepts of 'system' and 'control volume'. **(4)**

   (b) Give the statement of Zeroth law of thermodynamics and indicate its importance. **(6)**

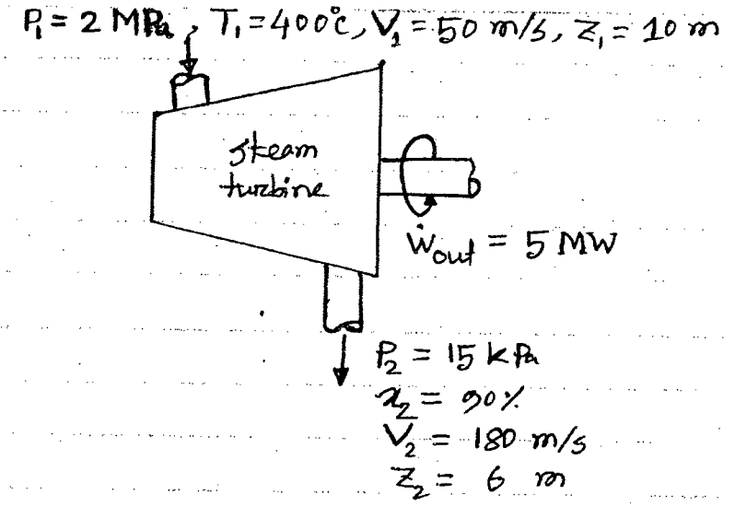
   (c) Indicate all possible mechanisms of energy transfer to an from a system. **(3)**

   (d) Draw and state the key features of P-V and P-T diagram for pure substance. **(14)**

   (e) Make a comparison between van der Waals and Virial equations of state. **(8)**

6. (a) Prove that the work (moving boundary work or pdv work) done during a polytropic process is- $W = PV \ln \frac{V_2}{V_1}$. **(10)**

   (b) The power output of an adiabatic steam turbine is 5 MW, and the inlet and the exit conditions of the steam are as indicated below. **(25)**



   (i) Compare the magnitudes of Δh, Δk_e and Δp_e.

   (ii) Determine the work done per unit mass of the steam flowing through the turbine.

   (iii) Calculate the mass flow rate of the steam.

7. (a) Write a short note on **(4×5=20)**

   (i) Energy has quality as well as quantity

   (ii) Perpetual-motion machine

   (iii) Carnot heat engine

   (iv) Co-efficient of performance

   (b) A house during winter is expected to be losing heat at a rate of 130,000 kJ/h when the outside temperature drops to –6°C. A heat pump is required to be used to heat the house. The house is to be maintained at 20°C at all times. Determine the minimum power required to drive this heat pump. **(8)**

Contd P/3

CHE 203

Contd ... Q. No. 7

(c) The food compartment of a refrigerator is maintained at 4°C by removing heat from it at a rate of 360 kJ/min. If the required power input to the refrigerator is 2 kW, determine the rate of heat rejection to the room that houses the refrigerator. **(7)**

8. (a) Sketch and explain briefly the T-s diagram of a pure substance. **(7)**

(b) Show graphically and explain the work saving in a two stage compression with intercooling. **(10)**

(c) Derive the first Tds, or Gibbs, equation which is $Tds = du + Pdv$ **(8)**

(d) Steam enters an adiabatic turbine at 5 MPa and 450°C and leaves at a pressure of 1.4 MPa. Determine the work output of the turbine per unit mass of steam if the process is reversible. **(10)**

EXTRA

L-2/T-1/CHE **Date : 19/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **EEE 267** (Electrical and Electronics Technology)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Design an analog computer circuit to solve the following differential equation. **(20)**

$$\frac{d^2v_0}{dt^2} + 3\frac{dv_0}{dt} + 2v_0 = 4\cos(10t),\ t > 0$$

subject to $v_0(0) = 2$, $v_0'(0) = 0$, where the prime refers to the time derivative.

(b) Design a single stage Op-Amp circuit to perform the following operation. **(15)**

$$v_0 = 3v_1 - 2v_2$$

All resistances must be $\leq 100\,\text{k}\Omega$

2. (a) A v-i characteristics representing a square law is shown in Fig. for Q. No. 2(a). **(20)**

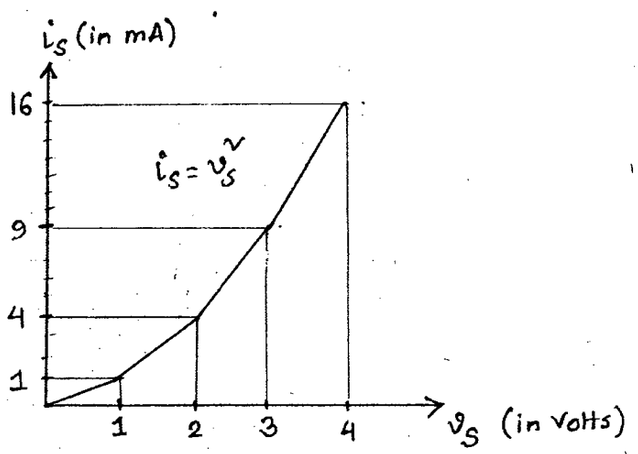


Fig. for Q. No. 2(a)

Now, design a diode circuit to generate this v-i characteristics.

(b) A particular "wave shaping" application requires the input-output characteristics illustrated in Fig. for Q. No. 2(b). **(15)**

Contd P/2

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Contd... Q. No. 2(b)

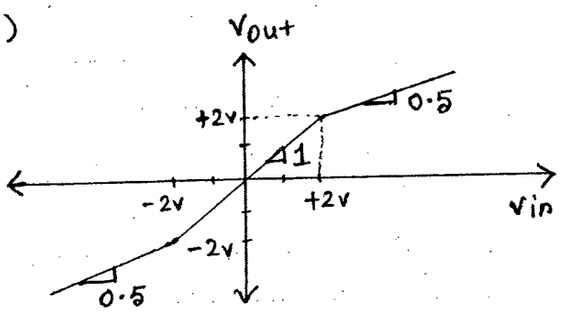

Fig. for Q. No. 2(b)

Using 1 kΩ resistors, ideal diodes, and other components construct the circuit that provides such input-output characteristics.

3. (a) Derive expressions for voltage gain and Input and Output Impedances of the circuits shown in Fig. for Q. No. 3(a)(i) and Fig. for Q. No. 3(a)(ii). Assume large value of capacitors and neglect the Early effect. **(12+12=24)**

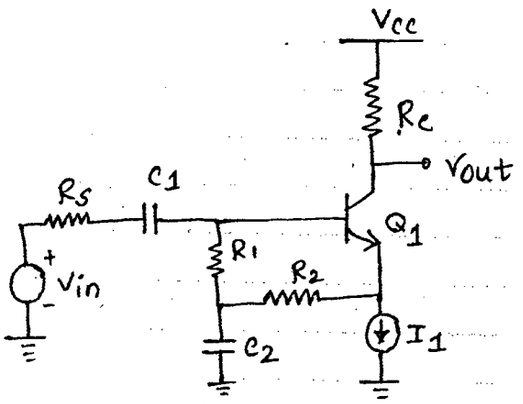

Fig. for Q. No. 3(a) (i)

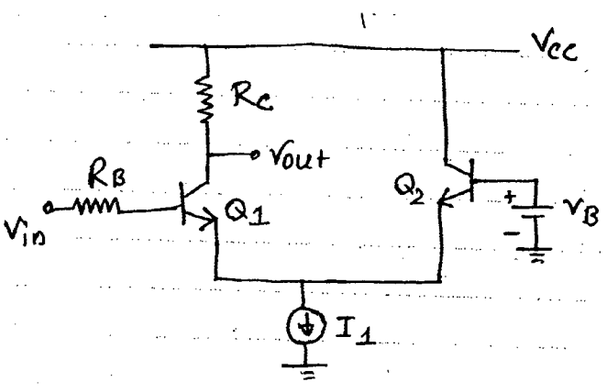

Fig. for Q. No. 3(a)(ii)

(b) Describe the working principle of an SCR by using "Two Transistor Model". **(11)**

4. (a) Show with neat diagrams and necessary mathematical expressions how piezoelectric crystal can be employed to construct a pressure sensor. **(15)**

(b) What is "Venturi Effect". Explain how this effect can be used to measure fluid flow rate. **(13)**

(c) Briefly discuss the working principle of a temperature sensor. **(7)**

Contd P/3

EEE 267

SECTION – B

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

5. (a) A 1 kVA 230/115 V single-phase transformer has been tested to determine its equivalent circuit. Test results are: **(20)**

Open Circuit Test	Short Circuit Test
$V_{oc} = 230$ V	$V_{sc} = 19.1$ V
$I_{oc} = 0.45$ A	$I_{sc} = 8.7$ A
$P_{oc} = 30$ W	$P_{sc} = 42.3$ W

(i) Draw the approximate equivalent circuit referred to primary side.

(ii) Find the voltage regulation of the transformer at rated conditions at 0.6 PF leading.

(iii) Find the efficiency of the transformer at rated conditions at 0.6 PF leading.

(b) (i) Explain how the leakage flux and magnetizing current is expressed in the equivalent circuit of the transformer. **(15)**

(ii) What additional approximation is made to derive the approximate equivalent circuit from the equivalent circuit of the transformer?

(iii) What is the reason why voltage ratio is not exactly equal to the turns ratio of actual transformers?

6. (a) Show that, the total instantaneous power absorbed by a three-phase load in a three-phase system is constant with respect to time. **(14)**

(b) For the circuit in Fig. for Q. No. 6(b), determine the total average power, reactive power, complex power absorbed/supplied by the source, transmission line and the load. **(21)**

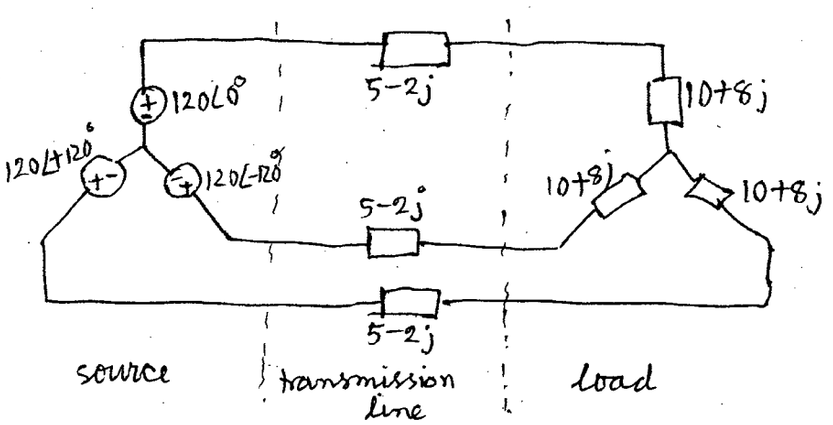

Fig. for Q. No. 6 (b)

EEE 267

7. (a) Show the connection diagrams of three phase wye-delta, delta-wye and wye-wye transformers. **(8)**

(b) Obtain $\frac{\text{line to line voltage at primary side}}{\text{line to line voltage at secondary side}}$ for three phase wye-delta, delta-wye and wye-wye transformer. For each case, number of turns at primary coil = a, number of turns at secondary coil = b. **(9)**

(c) Discuss the problems with commutations in DC machines. **(18)**

8. (a) With appropriate phasor diagram explain how the power factor angle of a synchronous motor changes as the load is increased. **(9)**

(b) With appropriate phasor diagram explain the function and use of synchronous capacitor. **(8)**

(c) A 2300 V, 1000 kVA, 60 Hz, 2 pole, Y-connected synchronous generator has a synchronous reactance of 1.1 Ω and negligible armature resistance. The field current has been adjusted so that terminal voltage is 2300 V at no load. What is the terminal voltage if it is loaded at **(18)**

(i) rated load at PF = 0.8 lagging

(ii) rated load at PF = 0.8 leading

(iii) rated load at PF = 1.

L-2/T-1/CHE **Date : 02/06/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **CHEM 235** (Physical Chemistry – II)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) What type of cell is the following one? **(12)**

$$Ag \mid AgCl(s), HCl(a_1) \mid HCl(a_2), AgCl(s) \mid Ag$$

Write the electrode reaction and cell reactions. Show the cell emf equation.

(b) Calculate cell emf of the above cell at 25°C when $a_1 = 0.01$, $a_2 = 0.1$ and $t_+ = 0.846$. Comment on the spontaneity of the cell reaction. **(5)**

(c) Construct a cell for a potentiometric titration of a ferrous iron containing solution with a standard solution of potassiumdichromate. Discuss the nature of change of cell potential during the titration. How can you find out the end point of the titration? **(11)**

(d) What are metal-insoluble salt electrodes? With a suitable example, discuss the working behaviour of the metal-insoluble salt electrodes. **(7)**

2. (a) Construct a chemical cell without transference using $CuSO_4$ as the electrolyte. Show the emf equation of the cell based on the cell reaction. **(7)**

(b) What is liquid junction potential? How is it minimized by using a salt bridge? How can the liquid junction potential practically be determined? **(6)**

(c) What is electromotive force (emf)? Discuss Poggendorff compensation method for the determination of emf directly. **(10)**

(d) What is hydrolysis? Discuss the nature of solutions produced after neutralization of different classes of acids and bases. Deduce the equation for the calculation of p^H of the salt solution produced after the neutralization of a weak acid with a strong base. **(12)**

3. (a) What is a buffer solution? Describe the buffer action of a solution containing a weak base and its salt with a suitable example. **(8)**

(b) Determine the solubility product constant of silverchromate when the solubility of silverchromate is 1.3×10^{-4} molL^{-1}. **(7)**

(c) Show the construction of a glass electrode and discuss its application. **(9)**

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(d) One litre solution is prepared by mixing sodium acetate and acetic acid. In the resulting solution the concentration of each substance is 0.1 M. 10 ml of 1 M HCl is added to the solution. Calculate the p^H of the solution before and after addition of hydrochloric acid. ($K_a = 1.75\times10^{-5}$ $molL^{-1}$) **(11)**

4. (a) What is a condensed-system? How is the phase rule modified for such a system? **(6)**

(b) What are the maximum number of phases that can coexist in solid-liquid equilibria of a two-component system? **(7)**

(c) What is incongruent melting point? Explain with a suitable example. **(8)**

(d) Draw the phase diagram of a two-component system (A and B) where two eutectic points are observed at 25 and 75 mol% of A and a sharp congruent melting point appears at equal mol fraction of A and B. Explain the phases and the degree of freedom in different regions of the diagram. **(14)**

SECTION – B

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

5. (a) What kind of transitions are possible when an organic material absorbs UV-VIS part of electromagnetic radiation? Show with an energy diagram. **(8)**

(b) What is an auxochrome? What are the main functions of an auxochrome in materials? **(8)**

(c) What are the origin of an absorption spectra in UV-VIS region of electromagnetic radiation for an inorganic compound? **(12)**

(d) Why infrared spectra is called as the finger print of a molecule? **(7)**

6. (a) What is multilayer adsorption? How BET equation **(4+3+8=15)**

(i) considers the multilayer adsorption?

(ii) can be applied for the determination of specific surface area?

(b) Catalytic promoters influence the catalytic activity of a catalyst— Explain with the help of adsorption theory. **(12)**

(c) What are the characteristic properties of an enzyme in catalysis? **(8)**

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7. (a) How is Guggenheilm method applied for the determination of order of a reaction? What are the main advantages of this method for such determination? **(12)**

(b) Draw and explain the concentration profile as a function of time for the following reaction (i) when $k_1 >> k_2$ and (ii) $k_2 >> k_1$ **(10)**

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

(c) With reference to ionic atmosphere and relaxation effect explain the Debye-Huckel theory of electrolytic conduction. **(13)**

8. (a) Rationalize the followings: **(5×5=25)**

(i) The equivalent conductance of electrolytes decreases with increasing concentration.

(ii) K^+ shows higher ionic mobility than Na^+ although K^+ is larger than Na^+.

(iii) For a weak electrolyte, the equivalent conductance at infinite dilution can be determined with the help of Kohlrausch's law of independent migration of ions.

(iv) H^+ and OH^- show abnormally high conductance values.

(v) Electrolytic conductance increases with increasing temperature.

(b) 0.5 N solution of a salt placed between two platinum electrodes 3.0 cm apart and of area of cross section 6.0 sq. cm has a resistance of 25 ohm. Calculate the equivalent conductance of the solution. **(10)**
