Nusrat Shirin

L-2/T-2/MME **Date : 06/07/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **MME 213** (Phase Diagrams and Transformations)

Full Marks: 280 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) What is ordering? How can you detect order in a solid solution?
(b) Ordering in some systems occur very rapidly, while in some systems it is relatively slow — explain why?
(c) Explain, with neat sketches, the various ordered structures that can form in cubic crystals.

2. (a) How do liquid-solid and solid-solid transformations differ?
(b) Classify solid state transformations on the basis of mechanism of growth process.
(c) Why does not equilibrium precipitate form directly from a supersaturated solid solution of a precipitation hardenable alloy if the ageing temperature is low?

3. (a) Explain, with a neat sketch, the equilibrium freezing of a ternary solid solution alloy, showing the path of composition changes during freezing.
(b) Show that in a single phase field in a ternary equilibrium diagram there are 3 degrees of freedom.
[You need to draw neat sketches and explain your answer. Mere deduction from the phase rule is not acceptable.]

4. (a) Draw a hypothetical concentration triangle of a ternary system showing complete solid insolubility.
Discuss the sequence of cooling of a least five typical alloys.
(b) Explain the determination of the composition and relative amounts of phases in a 3-phase field.
(c) Draw a vertical section radiating from one corner of the concentration triangle.

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MME 213

SECTION – B

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

The figures in the margin indicate full marks. Graph paper is supplied.

5. With reference to a hypothetical binary equilibrium phase diagram describe how coring occurs during solidification under normal industrial condition of a solid solution alloy. Describe how coring is (i) prevented and (ii) removed. **(46⅔)**

6. (a) Explain eutectic and eutectoid reactions with reference to typical thermal equilibrium diagrams. **(16)**

   (b) Bismuth (melting point 271 °C) and cadmium (melting point 321 °C) are assumed to be completely soluble in the liquid state and completely insoluble in the solid state. They form a eutectic at 143 °C containing 40 percent cadmium. **(30⅔)**

   (i) Draw the equilibrium diagram to scale on a piece of graph paper labeling all points, lines and areas.

   (ii) For a slow-cooled alloy containing 70 percent cadmium

   (a) give the temperature of initial solidification;

   (b) give the temperature of final solidification;

   (c) give the chemical composition and relative amounts of the phases present at a temperature of 35 °C below (a);

   (d) sketch the microstructure at room temperature; and

   (e) draw the cooling curve.

7. (a) Name the allotropic forms of iron and indicate the lattice structure of each. **(6⅔)**

   (b) Draw the iron and iron carbide thermal equilibrium diagram labeling all points, lines and phase fields. Define ferrite, pearlite and austenite. **(22)**

   (c) Describe the microstructural changes that occur in a low carbon steel containing 0.2 percent carbon during slow cooling from austenite range to room temperature. **(18)**

8. (a) Draw the I-T diagram for a eutectoid steel and label it completely. Show the continuous cooling curves superimposed on the I-T diagram to produce a microstructure consisting of: **(24)**

   (i) pearlite, (ii) bainite, (iii) martensite, (iv) bainite+martensite, (v) pearlite+bainite+martensite

   (b) What is martensite? Explain the mechanism of the formation of martensite. **(22⅔)**

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L-2/T-2/MME **Date : 22/07/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **HUM 103** (Economics)

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 do you mean by Production Possibility Frontier (PPF)? What will be the impact of the changes in technology and resources on the PPF? Compare the PPF of a poor nation and that of a rich nation. **(10)**

(b) Applying the knowledge of demand and supply show the following changes graphically. **(5×3=15)**

(i) IT business increases, price of laptop decreases.

(ii) Price of boat increases during flood.

(iii) Price (wages/salary) of Materials and Metallurgical Engineer rises.

(iv) Price of coffee increases, price of tea also increases.

(v) During the rainy season the price of umbrella rises.

(c) Given demand and supply equations **(10)**

$Q = P^{1/8}$ and $Q = 512/P$

Draw the demand and supply curves. Find out the equilibrium price and quantity and then show these graphically.

2. (a) Show graphically the relationship between 'total utility' and 'marginal utility'. **(10)**

(b) How can a consumer's equilibrium be obtained with the help of "law of equi-marginal utility"? **(15)**

(c) The utility function of Mr. Azim is given by $U = f(m, n) = m^{3/4} n^{1/4}$. Find out the optimal quantities of good 'm' and good 'n'. The prices of 'm' and 'n' are Tk. 6 per unit and Tk. 3 per unit respectively. The income of Mr. Azim is Tk. 120. **(10)**

3. (a) What is "paradox of bumber harvest"? **(10)**

(b) What Policies can be adopted to minimize the losses faced by the farmers during the bumper harvest? **(15)**

(c) From the data find the price elasticity of demand and make a comment on it. **(10)**

$P_1 = 90, Q_1 = 240, P_2 = 110, Q_2 = 160$

4. (a) What do you mean by 'vicious circle of poverty'? Explain the vicious circle on the 'demand side' and 'supply side' of capital formation. **(15)**

(b) What policies can be taken to break the 'vicious circle of poverty'? **(20)**

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HUM 103

SECTION – B

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

5. (a) Illustrate the concept of production function. **(5)**

   (b) Discuss the various types of returns to scale of production. **(10)**

   (c) Mathematically deduce the rational region of production of an engineering firm. **(20)**

6. (a) What is meant by the concept of market in economics? Describe the various classification of market. **(8)**

   (b) What are the assumptions of perfect competition? Explain them. **(7)**

   (c) Discuss the short-run equilibrium of a firm under perfect competition. **(10)**

   (d) Calculate the profit maximizing level of output and maximum profit from the following total revenue (TR) and total cost (TC) functions. **(10)**

   $TR = 5900Q - 10Q^2$

   $TC = 2Q^3 - 4Q^2 + 140Q + 845$

7. (a) Describe the circular flow of income and expenditure in a two sector economy. **(8)**

   (b) Briefly discuss the various methods of measuring national income with reference to the context of Bangladesh. **(9)**

   (c) Given that **(10)**

   GNP = Tk. 1,05,000 crore

   Depreciation = Tk. 9,000 crore

   Indirect tax = Tk. 12,500 crore

   Subsidy is 25% of indirect tax.

   Calculate national income.

   (d) Briefly discuss the following policies for controlling inflation with reference to the context of Bangladesh: **(8)**

   (i) Monetary policy

   (ii) Fiscal policy.

8. (a) Justify the statement — "the more inelastic the demand curve, the more tax burden on consumer, if the per unit tax is imposed on a producer". **(17)**

   (b) What will happen to the labour market if the government sets the minimum wage for the welfare of the low income earner (garments' workers)? Explain in detail. **(18)**

L-2/T-2/MME Date : 21/09/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **EEE 267** (Electrical and Electronic Engineering)

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) For a 3-ϕ induction motor (IM), show that P_{mech}: P_{gap}: $P_{r/c}$ = (1-s) : 1:s. Draw steinmetz equivalent circuit. **(10)**

(b) A 3-ϕ, 460 v, 25 hp, 50 Hz, four pole IM takes 14.58 kW as rotor input. The rotor Cu-loss is 263 W and combined friction, windage and stray losses are 197 W. Determine (i) Shaft speed, (ii) Mechanical power developed, and (iii) Developed torque. **(15)**

(c) For a 3-ϕ IM, show that developed torque, **(10)**

$$T_D = \frac{7.04\, P_{gap}}{n_s} \text{ lb-ft}$$

Draw the power stage of an IM (Induction Motor).

2. (a) Draw the phasor diagram of a single phase transformer for (i) lagging p.f. load, (ii) leading p.f. load, and (iii) unity p.f. load. Neglect no load branch. **(10)**

(b) Data for O.C.T and S.C.T of a single phase 25 kVA, 6900/230 V, 50 Hz, transformer are: **(15)**

O.T.C	S.C.T
V_{oc} = 230 V	V_{sc} = 513 V
I_{oc} = 5.4 A	I_{sc} = 3.6 A
P_{oc} = 260 W	P_{sc} = 465 W

(i) Determine $R_{fe,LS}$, $X_{M,LS}$, $R_{eq,HS}$, $X_{eq.HS}$ and $Z_{eq.HS}$.

(ii) Calculate efficiency if the p.f. of the load is 85%.

(c) Explain the working principle of a 3-ϕ induction motor. **(10)**

3. (a) A long shunt compound DC generator delivers 150 A at 230 V. The shunt field, series field, divertor and armature resistances are 92 Ω, 0.015 Ω, 0.03 Ω and 0.032 Ω, respectively. Determine (i) Induced emf, (ii) Total power generated, and (iii) Distribution of the generated power. **(10)**

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Contd... Q. No. 3

(b) A 460 V DC series motor runs at 500 rpm, taking a current of 40 A. Calculate the speed and % change in torque if the motor takes 30 A current. Given that the total resistance of the armature and field circuit is 0.8 Ω. **(10)**

(c) The input to 230 V DC shunt motor is 11 kV. The motor parameters are: **(15)**

No load current = 5 A, No-load speed = 1150 rpm

Armature resistance = 0.5 Ω, Shunt field resistance = 110 Ω

Calculate (i) Developed torque, (ii) Efficiency, and (iii) Rotational speed.

4. (a) Consider the Δ-Δ system shown below (Fig. for Q. 4(a)). **(15)**

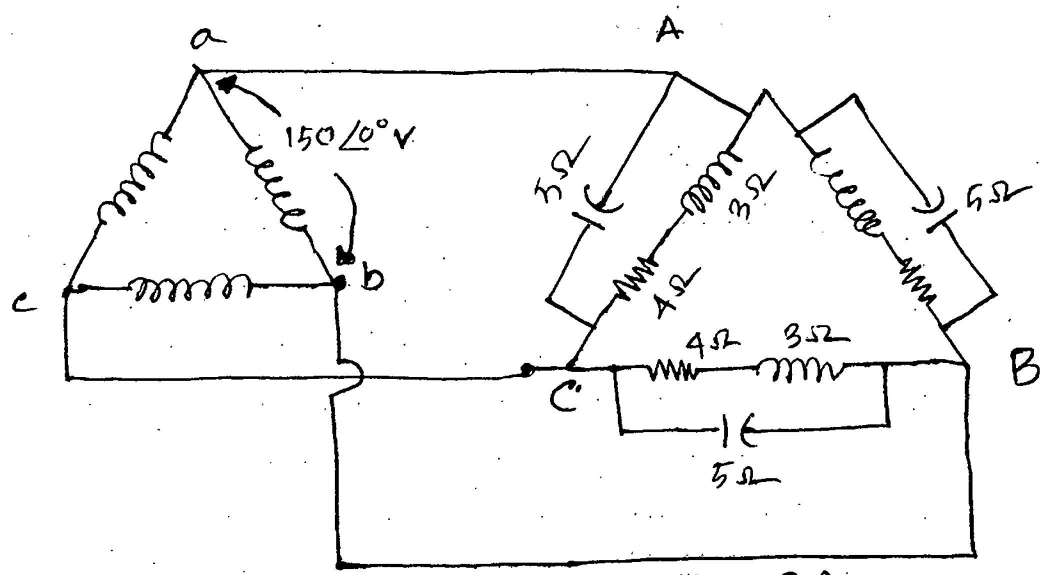

Fig. for Q. 4(a)

(i) Calculate the current in each phase of the load.

(ii) Find the total real power consumption of the load.

Assume that the phase sequence is acb.

(b) For a Y and Δ connected system, show that, **(5)**

$$P_{3-\phi} = \sqrt{3} V_L I_L \cos\theta_P$$

(c) A 75 KVA, 2400/240 V, 50 Hz, single phase transformer has the following parameters expressed in ohms: **(15)**

$R_{LS} = 0.006$, $R_{HS} = 2.5$, $R_{fe,HS} = 44200$

$X_{LS} = 0.01$, $X_{HS} = 4.8$, $X_{M,HS} = 7800$

The transformer is operating in step-down mode delivering 1/3 of the rated load at rated voltage and 0.92 p.f. lagging. Determine the total input impedance of the transformer with respect to its low voltage side.

Contd P/3

EEE 267

SECTION – B

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

5. (a) For a nonsalient pole three phase synchronous generator operating at lagging p.f. load, show that **(10)**

$$P = \frac{3V_\phi E_A \sin\delta}{X_s}$$

where, the symbols have their usual meaning.

(b) A three phase 200 kVA, 480 V, 50 Hz, Y-connected alternator has the following test parameters, **(10)**

(i) $V_{T,OC} = 540$ V, $I_{L,SC} = 300$ A

(ii) When a DC voltage of 10 V was applied to two of the terminal, a current of 25 A was measured.

Calculate the armature resistance and synchronous resistance.

(c) For a three phase synchronous motor, operating at leading p.f. show that, **(15)**

(i) $\delta = \tan^{-1}\left(\frac{I_A X_S \cos\theta}{V_\phi + I_A X_S \sin\theta}\right)$

(ii) $\tau_{max} = \frac{3V_\phi E_A}{\omega_m X_s}$

6. (a) A three phase 208 V, 45 kVA, 0.8 p.f. leading, Δ-connected, 50 Hz, synchronous motor has $X_S = 2.5$ Ω/phase and R_A is neglected. Its $P_{f,w} = 1.5$ kW and $P_{core} = 1.0$ kW. The shaft is supplying 15 hp load. Find I_A, I_L, and E_A. **(15)**

Now if the shaft load is increased to 30 hp, find I_A, I_L, E_A and motor p.f.

(b) For a resistive strain gauge, show that, gauge factor, $G_f = 1 + 2\gamma$, where the symbols have usual meanings. **(10)**

(c) Describe the construction and operation of an LVDT. **(10)**

7. (a) For the circuit shown below (Fig. for Q. 7(a)), calculate I, V_1, V_2 and V_0. **(10)**

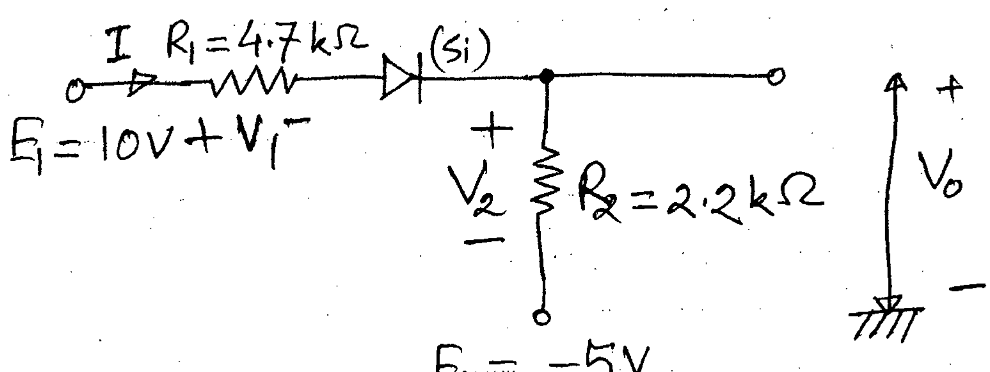

Fig for Q. 7(a).

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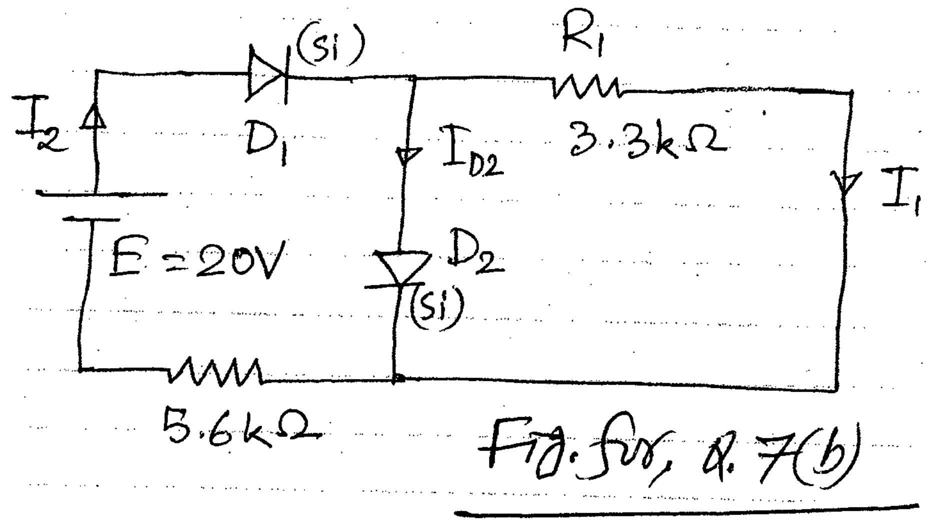
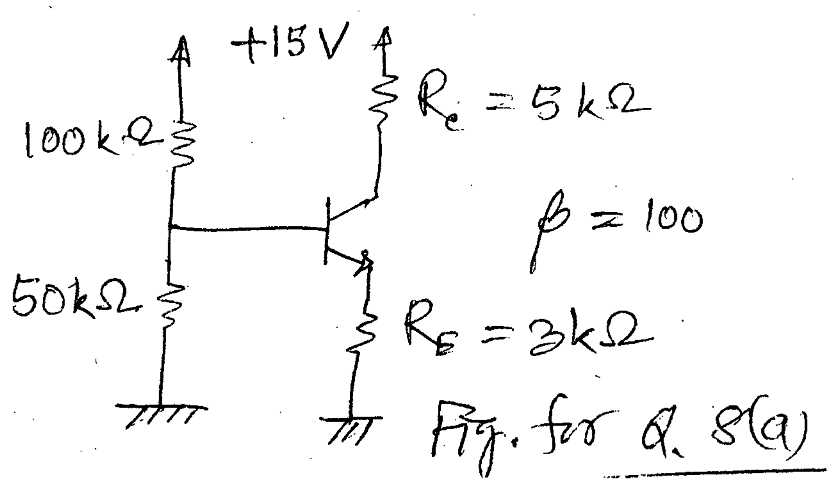
Contd... Q. No. 7

(b) For the circuit shown below, (Fig. for Q. 7(b)), find I_1, I_2 and I_{D2}. **(15)**



(c) Derive the expression of voltage gain for (i) Inverting amplifier (ii) non-inverting amplifier. **(10)**

8. (a) For the circuit shown below (Fig. for Q. 8(a)), determine, V_E, V_B, V_C, I_E, I_B and I_C (symbols have usual meanings). **(10)**



(b) For a full wave bridge rectifier using practical diodes, draw the output waveshape for sinusoidal input. Show that, **(15)**

(i) Average output, $V_{dc} = 0.636\,(V_m - 2V_{D0})$ and

(ii) Conduction angle, $\theta = \sin^{-1}\left(\frac{2V_D}{V_m}\right)$.

(c) Design a circuit using op-amp that takes three inputs of 5 V, 6 V and 9 V and gives output of 40 V. **(10)**

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L-2/T-2/MME **Date : 28/09/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **MME 235** (Heat and Mass Transfer)

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**.

Two pages containing tables and figures are attached.

1. (a) A small area $A_1 = 0.01\ m^2$ is known to emit diffusely at a temperature $T_1 = 800$ K with emissivity $\varepsilon_1 = 0.9$. Radiation emitted from the surface is intercepted by three other surfaces of areas $A_2 = 0.015\ m^2$, $A_3 = 0.02\ m^2$ and $A_4 = 0.025\ m^2$, which are 0.5 m from A_1 and are oriented as shown in Fig. 1(a). **(18)**
   - (i) What is the intensity associated with emission in each of the three directions?
   - (ii) What are the solid angles subtended by the three surfaces when viewed from A_1?
   - (iii) What is the rate at which radiation emitted by A_1 is intercepted by the three surfaces?

   (b) The interior walls of a furnace are maintained at 1500 K and can be regarded as black. The furnace has a 10 cm by 10 cm glass window which has spectral transmissivity to radiation at 1500 K given by **(17)**

   $$\tau_1 = 0.7 \text{ in } 0 < \lambda < 2\ \mu m$$
   $$\tau_2 = 0 \text{ in } 2 < \lambda < \infty$$

   - (i) Calculate the average transmissivity of the glass for radiation emitted at 1500 K.
   - (ii) Determine the rate of radiant energy transmitted through the window into the surrounding environment.

2. (a) Consider the perpendicular rectangles shown schematically in Fig. 2(a). Determine the shape factor F_{12}. **(15)**

   (b) A long cylindrical heater element of diameter D = 10 mm, temperature $T_1 = 1500$ K and emissivity $\varepsilon_1 = 1$ is used in the furnace shown in Fig. 2(b). The bottom area A_2 is diffuse, gray surface with $\varepsilon_2 = 0.6$ and is maintained at $T_2 = 500$ K. The side and top walls are fabricated from an insulating refractory brick that is diffuse and gray with $\varepsilon = 0.9$. The length of the furnace normal to the page is very large compared to the width ω and height h. Neglecting convection and treating the furnace walls as isothermal, **(20)**
   - (i) Determine the power per unit length that must be provided to the heating element to maintain steady-state conditions.
   - (ii) Calculate the temperature of the furnace wall.

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3. (a) Derive an expression for the log mean temperature difference for a counter flow heat exchanger. **(17)**

(b) A counter flow, concentric tube heat exchanger is to be used to cool lubricating oil from 80 to 50^0C with cooling water available at 20^0C. Water flows inside a tube with an inner diameter D_i = 25 mm at a rate of 0.08 kg/s, and oil flows through the annulus at a rate of 0.16 kg/s. The heat transfer coefficients for the water side and oil side are, respectively, h_w = 1000 $W/m^2.^0C$ and h_{oil} = 80 $W/m^2.^0C$; the fouling factors are F_w = 0.00018 $m^2.^0C/W$ and F_{oil} = 0.00018 $m^2.^0C/W$; and the tube wall resistance is negligible. Calculate the length of the tube required. The specific heats of water and oil can be taken as C_w = 4180 $J/kg.^0C$ and C_{oil} = 2090 $J/kg.^0C$. **(18)**

4. (a) Distinguish between velocity boundary layer and concentration boundary layer for flow over a flat surface. **(8)**

(b) Derive expressions for local and average mass transfer coefficients for flow over a flat surface. **(12)**

(c) At some location on the surface of a pan of water, measurements of the partial pressure of water vapor p_A (atm) are made as a function of the distance y from the surface, and the results are given below: **(15)**

y (mm)	0	1	2	3	4	5	6	7	8
$p_{A\,(atm)}$	0.12	0.09	0.062	0.044	0.032	0.024	0.02	0.02	0.02

Determine the convection mass transfer coefficient at this location.
(Use $D_{AB} = 0.288 \times 10^{-4}$ m^2/s, A: water vapor, B: air).

SECTION – B

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

One table is attached.

5. (a) Beginning with a differential control volume in the form of a cylindrical shell, derive the heat diffusion equation for a one dimensional, cylindrical, radial coordinate system with internal heat generation. **(18)**

(b) Consider one-dimensional steady-state heat conduction in a hollow cylinder with constant thermal conductivity in a region $a \le r \le b$. Heat is dissipated by convection into fluids following inside and outside the cylindrical tube. Heat transfer coefficient for the inside and outside fluids are h_a and h_b, respectively, and temperatures of inside and outside fluids are T_a and T_b, respectively. Write the mathematical formulation of this heat conduction problem. **(17)**

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MME 235

6. (a) A thin silicon chip and an 8-mm thick aluminium substrate are separated by a 0.02-mm-thick epoxy joint. The chip and substrate are each 10 mm on a side, and their exposed surfaces are cooled by air, which is at a temperature of 25^0C and provides a convection coefficient of 100 W/m^2 under normal conditions. Will it operate below a maximum allowable temperature of 85^0C? For pure aluminium (T~350 k) : k = 239 W/m.k. **(17)**

(b) A plane wall is a composite of two materials, A and B. The wall of material A has uniform heat generation of 1.5×10^6 W/m^3 with k_A = 75 W/m. K and thickness L_A = 50 mm. The wall material B has no heat generation with k_A = 150 W/m. K and thickness L_B = 20 mm. The inner surface of material B is cooled by a water stream with $T_\infty = 30^0$C and h = 1000 W/m^2. K. Sketch the temperature distribution that exists in the composite under steady-state conditions. **(18)**

7. (a) A long conducting rod of diameter D and Electrical resistance per unit length R_e' is initially in thermal equilibrium with the ambient air and its surroundings. This equilibrium is distributed when an electrical current I is passed through the rod. Develop an equation that could be used to compute the variation of the rod temperature with time during the passage of the current. **(16)**

(b) Consider the following one-dimensional, steady state heat conduction problem: **(19)**

$$d^2(T(x))/dx^2 + g.(1/k) = 0 \quad \text{in } 0 < x < L$$

$$d(T(x))/dx = 0 \quad \text{at } x = 0$$

$$k.(d(T(x))/dx) + hT(x) = 0 \quad \text{at } x = L$$

Write the finite difference formulation of this heat conduction problem by dividing the region $0 < x < L$ into four equal parts.

8. (a) The temperature of a gas stream is measured with a thermocouple. The junction may be approximated as a sphere of diameter D = 1 mm, k = 25 W/(m. ^{0}C), ρ = 8400 Kg/m^3, and c_p = 0.4 KJ/(Kg. ^{0}C). The heat transfer coefficient between the junction and the gas stream is h = 560 W/(m^2. ^{0}C). How long will it take for the thermocouple to record 99 percent of applied temperature difference? **(17)**

(b) A thick slab of cooper initially at a uniform temperature of 20^0C is suddenly exposed to radiation at one surface such that the net heat flux is maintained at a constant value of 3×10^6 W/m^2. Using the explicit and implicit finite-difference techniques with a space increment of Δx = 75 mm, determine the temperature at irradiated surface and at an interior point that is 150 mm from the surface after 2 min have elapsed. **(18)**

At 300 K, for copper: k = 401 W/m. K, $\alpha = 117 \times 10^{-6}$. m^2/s.

Table 12.1 Blackbody radiation functions[a]

λT (μm · K)	$F_{(0 \to \lambda)}$	$I_{\lambda,b}(\lambda,T)/\sigma T^5$ (μm · K · sr)$^{-1}$	$\dfrac{I_{\lambda,b}(\lambda,T)}{I_{\lambda,b}(\lambda_{max},T)}$
200	0.000000	0.375034×10^{-27}	0.000000
400	0.000000	0.490335×10^{-13}	0.000000
600	0.000000	0.104046×10^{-8}	0.000014
800	0.000016	0.991126×10^{-7}	0.001372
1,000	0.000321	0.118505×10^{-5}	0.016406
1,200	0.002134	0.523927×10^{-5}	0.072534
1,400	0.007790	0.134411×10^{-4}	0.186082
1,600	0.019718	0.249130	0.344904
1,800	0.039341	0.375568	0.519949
2,000	0.066728	0.493432	0.683123
2,200	0.100888	0.589649×10^{-4}	0.816329
2,400	0.140256	0.658866	0.912155
2,600	0.183120	0.701292	0.970891
2,800	0.227897	0.720239	0.997123
2,898	0.250108	0.722318×10^{-4}	1.000000
3,000	0.273232	0.720254×10^{-4}	0.997143
3,200	0.318102	0.705974	0.977373
3,400	0.361735	0.681544	0.943551
3,600	0.403607	0.650396	0.900429
3,800	0.443382	0.615225	0.851737
4,000	0.480877	0.578064	0.800291
4,200	0.516014	0.540394×10^{-4}	0.748139
4,400	0.548796	0.503253	0.696720
4,600	0.579280	0.467343	0.647004
4,800	0.607559	0.433109	0.599610
5,000	0.633747	0.400813	0.554898
5,200	0.658970	0.370580×10^{-4}	0.513043
5,400	0.680360	0.342445	0.474092
5,600	0.701046	0.316376	0.438002
5,800	0.720158	0.292301	0.404671
6,000	0.737818	0.270121	0.373965
6,200	0.754140	0.249723×10^{-4}	0.345724
6,400	0.769234	0.230985	0.319783
6,600	0.783199	0.213786	0.295973
6,800	0.796129	0.198008	0.274128
7,000	0.808109	0.183534	0.254090
7,200	0.819217	0.170256×10^{-4}	0.235708
7,400	0.829527	0.158073	0.218842
7,600	0.839102	0.146891	0.203360
7,800	0.848005	0.136621	0.189143
8,000	0.856288	0.127185	0.176079
8,500	0.874608	0.106772×10^{-4}	0.147819
9,000	0.890029	0.901463×10^{-5}	0.124801
9,500	0.903085	0.765338	0.105956
10,000	0.914199	0.653279	0.090442
10,500	0.923710	0.560522	0.077600
11,000	0.931890	0.483321×10^{-5}	0.066913
11,500	0.939959	0.418725	0.057970
12,000	0.945098	0.364394	0.050448
13,000	0.955139	0.279457	0.038689
14,000	0.962898	0.217641	0.030131
15,000	0.969981	0.171866×10^{-5}	0.023794
16,000	0.973814	0.137429	0.019026
18,000	0.980860	0.908240×10^{-6}	0.012574
20,000	0.985602	0.623310	0.008629
25,000	0.992215	0.276474	0.003828
30,000	0.995340	0.140469×10^{-6}	0.001945
40,000	0.997967	0.473891×10^{-7}	0.000656
50,000	0.998953	0.201605	0.000279
75,000	0.999713	0.418597×10^{-8}	0.000058
100,000	0.999905	0.135752	0.000019

[a] The radiation constants used to generate these blackbody functions
$C_1 = 3.7420 \times 10^8$ μm^4/m^2
$C_2 = 1.4388 \times 10^4$ μm · K
$\sigma = 5.670 \times 10^{-8}$ W/m^2 · K^4.

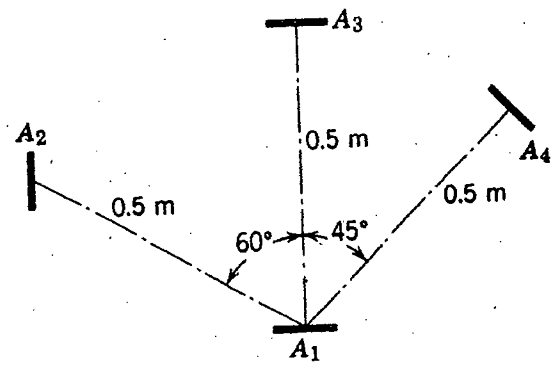


Fig.1(a) for Q.No.1(a)

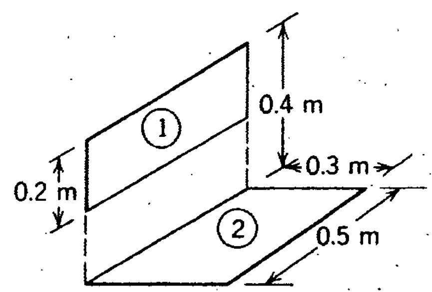


Fig.2(a) for Q.No.2(a)

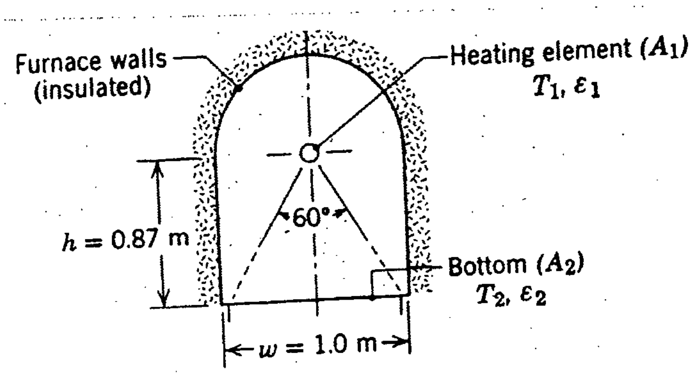
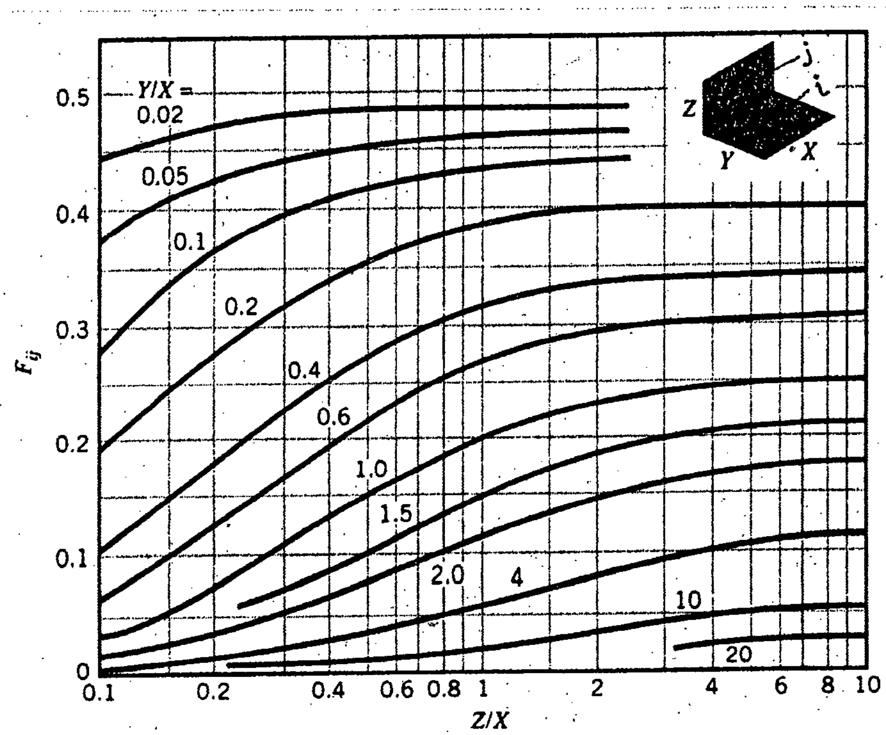


Fig.2(b) for Q.No.2(b)



[redacted] View factor for perpendicular rectangles with a common edge.

TABLE 3.2 Thermal resistance of representative solid/solid interfaces

Interface	$R''_{t,c} \times 10^4$ ($m^2 \cdot K/W$)	Source
Silicon chip/lapped aluminum in air (27–500 kN/m^2)	0.3–0.6	[2]
Aluminum/aluminum with indium foil filler (~100 kN/m^2)	~0.07	[1, 3]
Stainless/stainless with indium foil filler (~3500 kN/m^2)	~0.04	[1, 3]
Aluminum/aluminum with metallic (Pb) coating	0.01–0.1	[4]
Aluminum/aluminum with Dow Corning 340 grease (~100 kN/m^2)	~0.07	[1, 3]
Stainless/stainless with Dow Corning 340 grease (~3500 kN/m^2)	~0.04	[1, 3]
Silicon chip/aluminum with 0.02-mm epoxy	0.2–0.9	[5]
Brass/brass with 15-μm tin solder	0.025–0.14	[6]

Table for question no. 6(a)

L-2/T-2/MME Date : 05/10/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **ME 221** (Elements of Fluid Mechanics and Machinery)

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) Derive the Euler's pump head equation in the following form **(20)**

$$E = \frac{1}{2g}\left\{\left(v_2^2 - v_1^2\right) + \left(u_2^2 - u_1^2\right) + \left(v_{r1}^2 - v_{r2}^2\right)\right\}$$

Interpret the physical meaning of each term.

(b) A radial flow pump has the following dimensions: **(15)**

$$\beta_1 = 46^\circ \quad r_1 = 21mm \quad b_1 = 11mm$$

$$\beta_2 = 32^\circ \quad r_2 = 66mm \quad b_2 = 5mm$$

For a rotational speed of 2500 rpm with radial inflow, determine–

(i) Discharge

(ii) Theoretical head developed

(iii) Power developed by the pump.

2. (a) Show that the ideal pump performance for a centrifugal pump follows the relation $H_T = a_0 - a_1\dot{Q}$, where the symbols have their usual meanings.

Is there any deviation of actual pump performance from the ideal one? If there is any, then state the reasons for this deviation. **(15)**

(b) The external and internal diameters of an impeller of a centrifugal pump are 450 mm and 250 mm, respectively. The pump delivers 200 l/s water at a speed of 1250 rpm. The outside and inside widths of the impeller are 70 mm and 150 mm, respectively. The vanes are curved backward at an angle of 30^0 at exit. If the manometric efficiency is 82%, find the head developed by the pump. Water enters the impeller radially. **(15)**

(c) What do you mean by NPSH? **(5)**

3. (a) Draw the schematic diagram of a Pelton wheel. Show that the maximum theoretical efficiency of the Pelton wheel is $\eta_{max} = \frac{1}{2}(1 - k\cos\theta)$, where the symbols have their usual meanings. **(15)**

(b) A Pelton wheel working under a head of 250 m is supplied with 200 l/s of water. The bucket speed is 16 m/s and the jet is deflected through an angle of 165^0. Find the power developed by the turbine and the hydraulic efficiency. Consider, $C_v = 0.98$. **(15)**

(c) Draw a typical indicator diagram in context to a reciprocating pump. **(5)**

Contd P/2

4. (a) Derive an expression for the measurement of actual flow rate using an Orificemeter. **(15)**

(b) Deduce the conditions for the most economical section of a trapezoidal open channel. **(15)**

(c) A rectangular open channel carries water at the rate of 500 l/s when the bed slope is 1 in 1800. Calculate the most economical dimensions of the channel. Take Chezy's constant, $C = 50$. **(5)**

SECTION – B

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

Assume reasonable value for missing data. Moody diagram is supplied.

5. (a) Define Newtonian and Non-Newtonian fluids. Give three examples of each. **(6)**

(b) Show that for a submerged plane surface, the center of pressure is always below the center of gravity of the surface. **(12)**

(c) Determine the depth of water "d" which will cause the rectangular gate to fall as shown in Fig. for Q. No. 5(c). Neglect the weight of the gate. **(17)**

6. (a) Derive Bernoulli's equation for fluid flow applying the law of motion. Write the significance of different terms of this equation. Is this equation applicable for both ideal and real fluid flows? **(17)**

(b) Water flows at the rate of 200 litr/s through a reducer as shown in Fig. for Q. No. 6(b). Find the deflection in the mercury manometer. Neglect frictional losses. **(18)**

7. (a) For laminar flow through pipe, show that the average velocity is half of the maximum velocity. List all the assumptions considered here. **(17)**

(b) Certain oil with dynamic viscosity 1.4 $N\text{-}s/m^2$ and specific weight 8.9 kN/m^3 is flowing through a pipe of 100 mm diameter. If the length of pipe is 600 m, find the flow-rate and head loss considering Reynolds no. as 800. **(18)**

8. (a) At point A as shown in Fig. for Q. No. 8(a), the gage pressure is –20 kPa. Find specific gravity of liquid B. **(15)**

(b) Petroleum oil is flowing through an inclined galvanized pipe at the rate of 0.3 m^3/s as shown in Fig. for Q. No. 8(b). At point 1 pressure is 2500 kPa and at point 2 pressure is atmospheric. Neglecting minor losses, find the diameter of the pipe. Specific gravity of petroleum oil is 0.72 and its absolute viscosity is 2.9×10^{-4} Ns/m^2. **(20)**

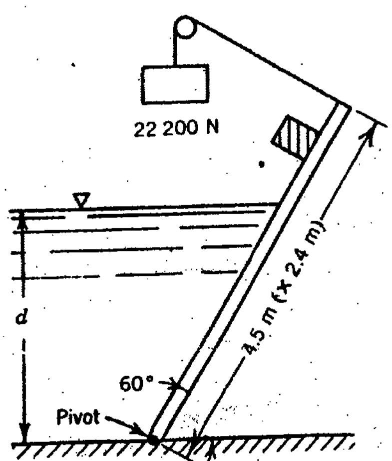


Fig. for Q. NO. 5(c)

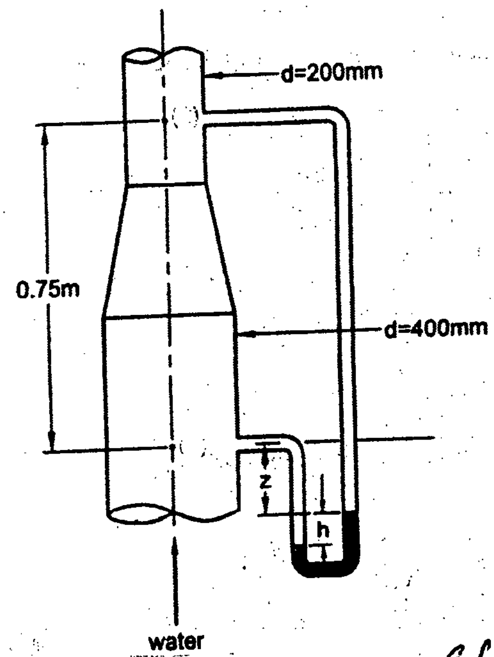


Fig. for Q. NO. 6(b)

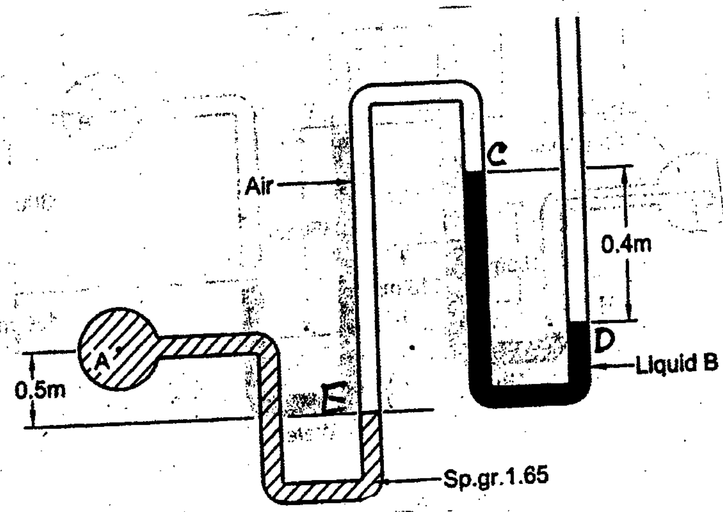


Fig. for Q. NO. 8(a)

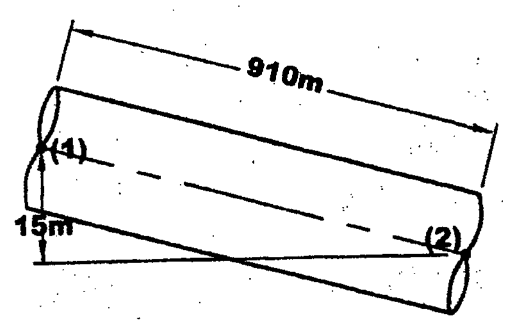
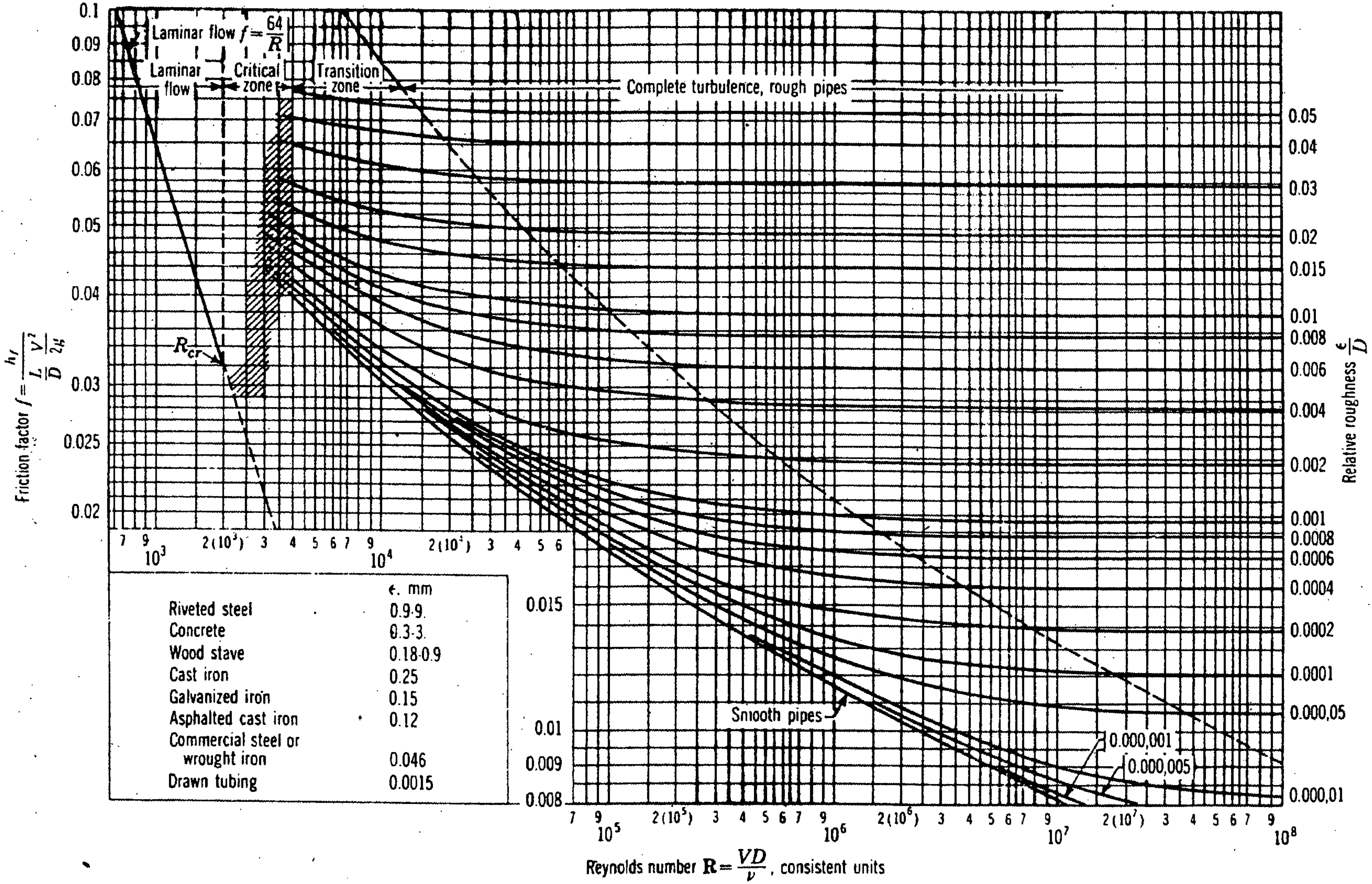


Fig. for Q. NO. 8(b)



Moody diagram.