L-2/T-1/ME **Date: 20/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2016-2017

Sub: **EEE 259** (Electrical and Electronics Technology)

Full Marks: 280 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) A synchronous motor runs is synchronous speed but an induction motor cannot. Explain. **(12)**

(b) Draw the Power Flow Diagrams of Synchronous generator and induction motor. For a 3-phase induction motor show that $P_{conv}:P_{air\text{-}gap}:P_{RCL}=(1\text{-}s):1:s$. **(18)**

(c) A 208-V, 60 Hz six-pole, Y-connected, 25-hp design class B induction motor is tested in the laboratory, with the following results: **($16\frac{2}{3}$)**

No load: 208 V, 22.0 A, 1200 W, 60 Hz

Locked rotor: 24.6 V, 64.5 A, 2200 W, 15 Hz

DC test: 13.5 V, 64 A

Find the equivalent circuit of this motor

(For Design Class B, $X_1 = 0.4X_{LR}$ and $X_2 = 0.6X_{LR}$)

2. (a) In the same figure draw Induced torque vs. motor speed and Power converted vs. motor speed for an induction motor. What is plugging? Two induction motors are rotating at two different speeds. Can we conclude about which motor is having higher output power? **(10)**

(b) Explain the effect of changes of field current in synchronous motor. Describe the V-curve. **($11\frac{2}{3}$)**

(c) A 208-V, 45-kVA, 0.8-PF-leading, Δ-connected, 60-Hz synchronous machine has a synchronous reactance of 2.5 Ω and a negligible armature resistance. Its friction and windage losses are 1.5 kW and its core losses are 1 kW. Initially, the shaft is supplying a 15-hp load, and the motor's power factor is 0.80 leading. **(25)**

(i) Find the values of I_A, I_L and E_A.

(ii) Assume that the shaft load is now increased to 30 hp. Find I_A, I_L and E_A after the load change. What is the new motor power factor?

Contd P/2

3. (a) Write the conditions for parallel operation of AC generators. **(10⅔)**

(b) What do you understand by Infinite Bus? In case of operation of generators in parallel with large power system, why the frequency of the oncoming generator is to be kept higher than that of the running system. Explain the following cases in brief with related figures **(16)**

(i) When a generator is connected, what happens when its governor set points are increased

(ii) Increasing the field current in a synchronous generator operating in parallel with an infinite bus.

(c) A 480-V, 50-Hz, Y-connected, six-pole synchronous generator has a per-phase synchronous reactance of 1.0 Ω. Its full-load armature current is 60 A at 0.8 PF lagging. This generator has friction and windage losses of 1.5 kW and core losses of 1.0 kW at 60 Hz at full load. The armature resistance is being ignored. The field current has been adjusted so that the terminal voltage is 480 V at no load. **(20)**

(i) What is the speed of rotation of this generator?

(ii) What is the terminal voltage of this generator if it is loaded with the rated current at 0.8 PF lagging?

(iii) What is the efficiency of this generator?

(iv) How much shaft torque must be applied by the prime mover at full load?

(v) What is the voltage regulation of the generator?

4. (a) Why transformer is needed? Explain in brief. **(10)**

Let two systems have voltage regulation 0 and –1, respectively. Which one you would recommend? Why?

(b) Explain the losses in transformer in brief. **(11⅔)**

(c) A 1-kVA. 230/115-V, 60-Hz distribution transformer is tested with the following results: **(25)**

Open-circuit test	**Short-circuit test**
$I_{OC} = 0.11$ A	$V_{SC} = 17.1$ V, $I_{SC} = 8.7$ A
$P_{OC} = 3.9$ W	$P_{SC} = 38.1$ W

(i) Find the equivalent circuit for this transformer referred to low voltage side.

(ii) Find the voltage regulation at the rated conditions and 0.8 PF lagging.

(iii) Find the efficiency at the rated conditions and 0.8 PF lagging.

Contd P/3

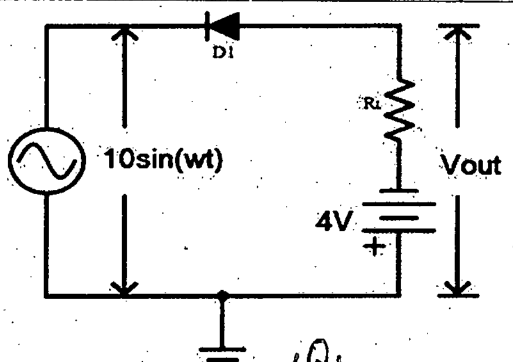
SECTION-B

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

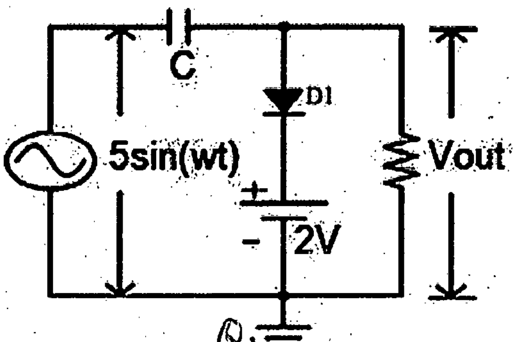
5. (a) "PIV of a diode is an important parameter when the diode is to be used as a rectifier" — why? **(6)**

(b) Draw the circuit diagram of a voltage doubler and state the function of different blocks in it. Also show the output wave form for an arbitrary input sinusoidal signal. **(5+5)**

(c) Draw the output waveforms by clearly stating the voltage levels. **(7+7)**



Circiut 1 (Fig. for Q. 5(c))



Circuit 2 (Fig. for Q. 5(c))

(d) Find the current through all the diodes in the following circuit assuming ideal diodes. **(16⅔)**

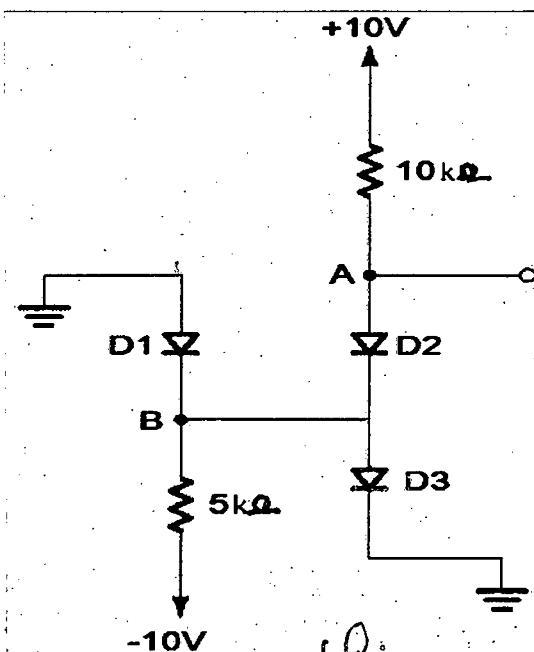


Fig. for Q. 5(d)

6. (a) Why MOSFETs are widely used specially in ICs compared to BJTs? **(6⅔)**

(b) Show that the current at the edge of saturation for MOSFETs is proportional to the square of the overdrive voltage. **(10)**

EEE 259(ME)

Contd... Q. No. 6

(c) Analyze the circuit shown in Fig. for Q. 6(c) to determine the voltages at all nodes. Let V_{tn} = 1 V and $k_n'(W/L) = 1mA/V^2$. **(20)**

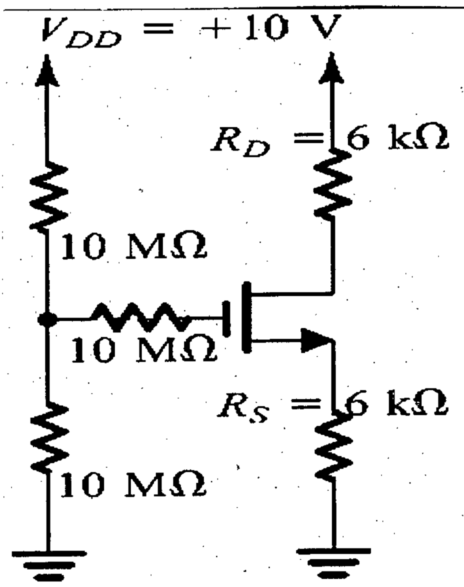


Fig. for Q. 6(c)

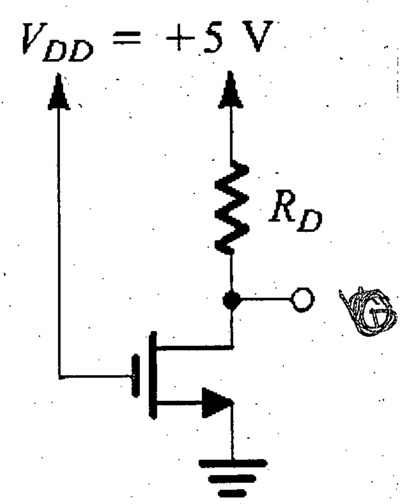


Fig. for Q. 6(d)

(d) Design the circuit in Fig. for Q. 6(d) to establish a drain voltage of 0.1 V. Let V_{tn}=1 V and $k_n'(W/L) = 1mA/V^2$. **(10)**

7. (a) Draw the i_C-V_{CE} characteristics curve of a practical BJT mentioning the operating mode on the plot. **(10)**

(b) Analyze the circuit of Fig. 7(b) to determine the voltages at all nodes and the currents through all branches. Assume that the transistor β is specified to be *at least* 50. **(20)**

(c) If the base voltage in Fig. 7(b) is decreased by 2V, what will be the new node voltages and branch currents? This time assume β is specified to be 100 for active mode operation. **(16⅔)**

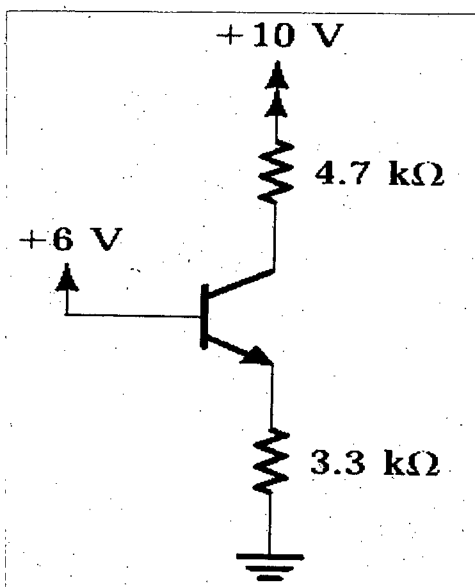


Fig. 7(b)

EEE 259(ME)

8. (a) What are the methods of speed control of a shunt DC motor? Describe the less common method with the associated torque-speed characteristics curve. **(5+10)**

(b) What are the main constructional differences between AC generators and DC generators? Sate the problems associated with commutation and how they can be overcome? What is armature reaction? **(5+5+5)**

(c)Draw the equivalent circuit diagram for a separately excited and a self excited shunt DC generator? Which one can be modified to represent the PMDC generator? What will be the modification? **(16⅔)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2016-2017

Sub: **ME 203** (Engineering Thermodynamics)

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**.

Data tables are attached.

1. (a) Make a brief comparison between 'Heat' and 'Work'. Show that, work is a path function. **(8)**

   (b) Explain the physical meanings of **(12)**

   (i) boundary work, (ii) shaft work, (iii) flow work.

   (c) A gas in a piston-cylinder assembly undergoes a polytropic process Pv^n = constant. If $P_0 = 0.1$ MPa and $V_0 = 0.01\ m^3$, and final volume is $0.02\ m^3$. Calculate the work and heat transfer if **(15)**

   (i) $n = 1.4$, (ii) $n = 0$, (iii) $n = 1.0$.

2. (a) Explain 'thermodynamic equilibrium'. State 'Zeroth law' of thermodynamics. **(8)**

   (b) Using first law of thermodynamics, show that internal energy is a thermodynamic property, and explain the physical meaning of internal energy. **(12)**

   (c) Refrigerant R134a enters a compressor at a steady state as saturated vapour at 0.1 MPa and exits at 1.0 MPa and 65°C at a mass flow rate of 0.05 kg/s. Heat loss from the compressor is 0.1 kW. Estimate the power input required and first law efficiency of the compressor. **(15)**

3. (a) Briefly present first law of thermodynamics for open system and derive Bernoulli's equation from it. **(8)**

   (b) Explain the physical meanings of **(12)**

   (i) Thermal efficiency, (ii) First law efficiency, (iii) Second law efficiency.

   (c) Air at 1.5 MPa, 400 K and a velocity of 40 m/s enters a nozzle at a steady state and expands adiabatically to the exit, where the pressure is 0.01 MPa and velocity is 300 m/s. Assuming air as an ideal gas, estimate **(15)**

   (i) temperature at the nozzle exit, (ii) isentropic nozzle efficiency.

Contd P/2

ME 203

4. (a) Briefly present 'Kelvin-Planck' statement of 2^{nd} law of thermodynamics. Explain the key observations made from the statements of 2^{nd} law of thermodynamics. **(8)**

(b) Using suitable assumptions, show that for isentropic process, Pv^k = const. **(12)**

(c) One kilogram of water at 0°C and one kilogram of saturated steam at 100°C are mixed in a constant pressure and adiabatic process. Find the final temperature and the entropy generation for the process. **(15)**

SECTION-B

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

Assume a reasonable value for any missing data. All the symbols have their usual meaning.

5. (a) Deduce an expression for air standard thermal efficiency of a diesel cycle. **(18)**

(b) The pressure and temperature of air at the beginning of compression in an Otto cycle is 100 kPa and 27°C respectively. During the combustion, heat added per kg of air is 1900 kJ. If the engine has a compression ratio of 8, determine the following for an air standard cycle— **(17)**

(i) Maximum temperature, (ii) Thermal efficiency, (iii) MEP.

6. (a) How do the following quantities change (increase or decrease or remain same) when a simple ideal Rankine cycle is modified with reheating? **(7½)**

(i) Pump work input, (ii) Turbine work output, (iii) Heat supplied,

(iv) Heat rejected, (v) Moisture content at the turbine exit.

[Assume the mass flow rate is maintained the same.]

(b) The closed feedwater heater of a regenerative Rankine cycle is to heat 7000 kPa feedwater from 260°C to saturated liquid. The turbine supplies bleed steam at 6000 kPa and 325°C to this unit. The steam is condensed to saturated liquid before entering the pump. Calculate the amount of bleed steam required to heat 1 kg of feedwater in this unit. **(20)**

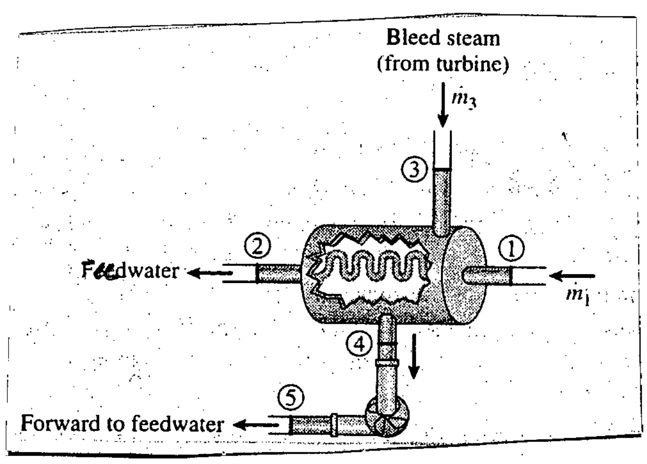


Fig. for Q. No. 6(b)

(c) Why is the combined gas-steam cycle more efficient than either of the cycles operated alone? What is the difference between the binary vapor power cycle and the combined gas-steam power cycle? **(7½)**

Contd P/3

7. (a) A room contains air at 20°C and 98 kPa at a relative humidity of 85 percent. Determine: **(8)**
   - (i) partial pressure of the dry air,
   - (ii) the specific humidity of the air, and
   - (iii) the enthalpy per unit mass of dry air.

   (b) Air at 1 atm, 20°C, and 50 percent relative humidity is first heated to 35°C in a heating section and then passed through an evaporative cooler where its temperature drops to 25°C. Determine the: **(9)**
   - (i) the exit relative humidity,
   - (ii) the amount of air added to air, in kg H_2O/kg of dry air.

   (c) A simple vapor compression refrigeration cycle using R-134a operates at a condensing temperature of 40°C and an evaporative temperature of –10°C. For cooking capacity of 15 Tons, determine— **(18)**
   - (i) COP,
   - (ii) Mass flow rate of refrigerant (kg/s),
   - (iii) Required compressor power (kW).

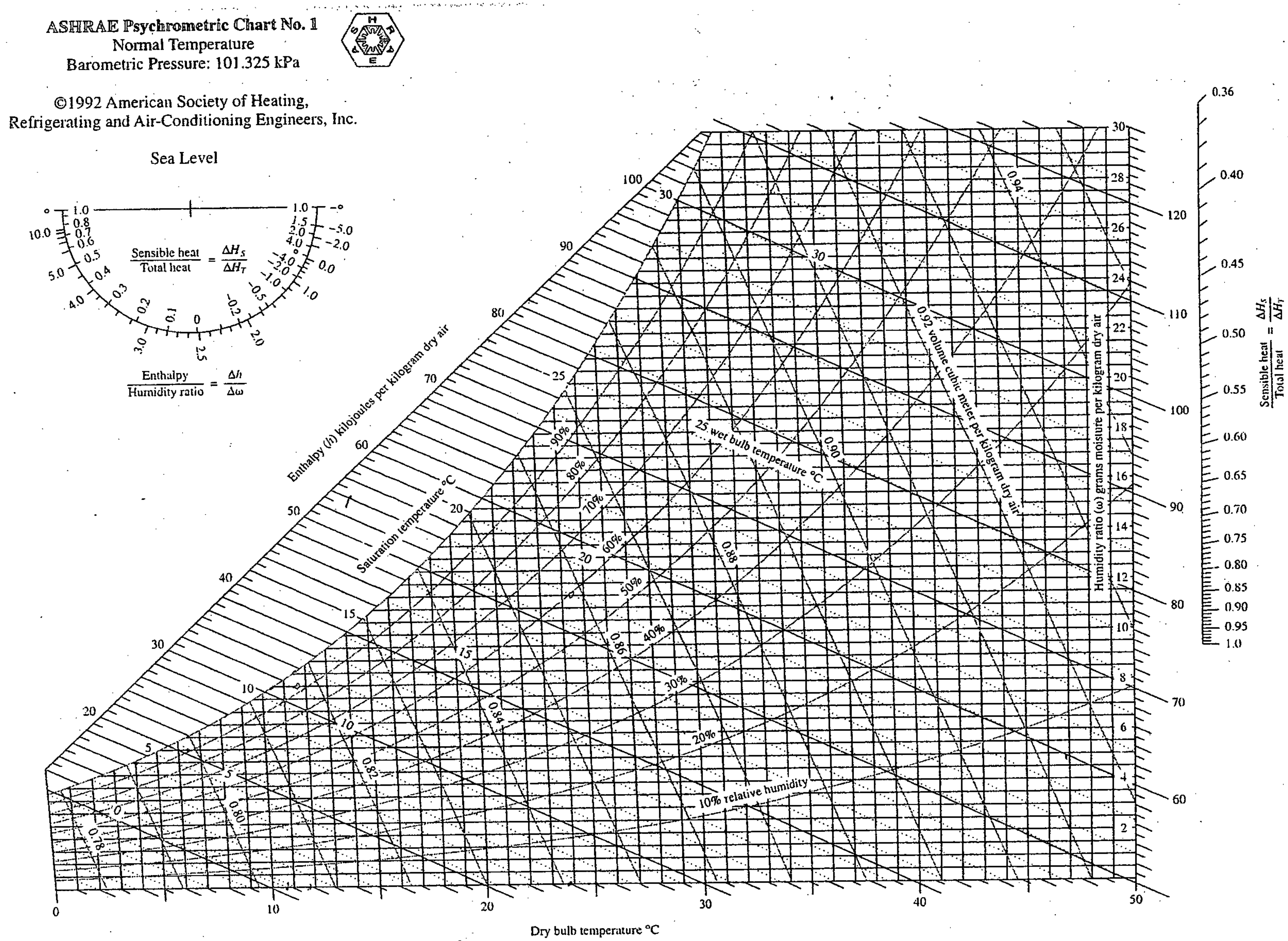
8. (a) What do you understand by "Regeneration" in a GT cycle? Briefly state the influence of pressure ratio on such a cycle. **(8)**

   (b) A Gas-turbine power plant operating on an ideal Brayton cycle has a pressure ratio of 8. The gas turbine is 300 K at the compressor inlet and 1300 K at the turbine inlet. Utilizing the cold air-standard assumptions, determine— **(17)**
   - (i) thermal efficiency,
   - (ii) back work ratio.

   (c) Write short notes on: **(10)**
   - (i) Clausius-Clapeyron equation.
   - (ii) Joule-Thomson coefficient.

ME 203

= 4 =



Prepared by Center for Applied Thermodynamic Studies, University of Idaho.

FIGURE A–31

Psychrometric chart at 1 atm total pressure.

Reprinted by permission of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA; used with permission.

ME 203

=5=

Water

H_2O

Properties of Saturated Water (Liquid–Vapor): Temperature Table

Temp. °C	Press. bar	Specific Volume m³/kg: Sat. Liquid $v_f \times 10^3$	Specific Volume m³/kg: Sat. Vapor v_g	Internal Energy kJ/kg: Sat. Liquid u_f	Internal Energy kJ/kg: Sat. Vapor u_g	Enthalpy kJ/kg: Sat. Liquid h_f	Enthalpy kJ/kg: Evap. h_{fg}	Enthalpy kJ/kg: Sat. Vapor h_g	Entropy kJ/kg·K: Sat. Liquid s_f	Entropy kJ/kg·K: Sat. Vapor s_g	Temp. °C
.01	0.00611	1.0002	206.136	0.00	2375.3	0.01	2501.3	2501.4	0.0000	9.1562	.01
4	0.00813	1.0001	157.232	16.77	2380.9	16.78	2491.9	2508.7	0.0610	9.0514	4
5	0.00872	1.0001	147.120	20.97	2382.3	20.98	2489.6	2510.6	0.0761	9.0257	5
6	0.00935	1.0001	137.734	25.19	2383.6	25.20	2487.2	2512.4	0.0912	9.0003	6
8	0.01072	1.0002	120.917	33.59	2386.4	33.60	2482.5	2516.1	0.1212	8.9501	8
10	0.01228	1.0004	106.379	42.00	2389.2	42.01	2477.7	2519.8	0.1510	8.9008	10
11	0.01312	1.0004	99.857	46.20	2390.5	46.20	2475.4	2521.6	0.1658	8.8765	11
12	0.01402	1.0005	93.784	50.41	2391.9	50.41	2473.0	2523.4	0.1806	8.8524	12
13	0.01497	1.0007	88.124	54.60	2393.3	54.60	2470.7	2525.3	0.1953	8.8285	13
14	0.01598	1.0008	82.848	58.79	2394.7	58.80	2468.3	2527.1	0.2099	8.8048	14
15	0.01705	1.0009	77.926	62.99	2396.1	62.99	2465.9	2528.9	0.2245	8.7814	15
16	0.01818	1.0011	73.333	67.18	2397.4	67.19	2463.6	2530.8	0.2390	8.7582	16
17	0.01938	1.0012	69.044	71.38	2398.8	71.38	2461.2	2532.6	0.2535	8.7351	17
18	0.02064	1.0014	65.038	75.57	2400.2	75.58	2458.8	2534.4	0.2679	8.7123	18
19	0.02198	1.0016	61.293	79.76	2401.6	79.77	2456.5	2536.2	0.2823	8.6897	19
20	0.02339	1.0018	57.791	83.95	2402.9	83.96	2454.1	2538.1	0.2966	8.6672	20
21	0.02487	1.0020	54.514	88.14	2404.3	88.14	2451.8	2539.9	0.3109	8.6450	21
22	0.02645	1.0022	51.447	92.32	2405.7	92.33	2449.4	2541.7	0.3251	8.6229	22
23	0.02810	1.0024	48.574	96.51	2407.0	96.52	2447.0	2543.5	0.3393	8.6011	23
24	0.02985	1.0027	45.883	100.70	2408.4	100.70	2444.7	2545.4	0.3534	8.5794	24
25	0.03169	1.0029	43.360	104.88	2409.8	104.89	2442.3	2547.2	0.3674	8.5580	25
26	0.03363	1.0032	40.994	109.06	2411.1	109.07	2439.9	2549.0	0.3814	8.5367	26
27	0.03567	1.0035	38.774	113.25	2412.5	113.25	2437.6	2550.8	0.3954	8.5156	27
28	0.03782	1.0037	36.690	117.42	2413.9	117.43	2435.2	2552.6	0.4093	8.4946	28
29	0.04008	1.0040	34.733	121.60	2415.2	121.61	2432.8	2554.5	0.4231	8.4739	29
30	0.04246	1.0043	32.894	125.78	2416.6	125.79	2430.5	2556.3	0.4369	8.4533	30
31	0.04496	1.0046	31.165	129.96	2418.0	129.97	2428.1	2558.1	0.4507	8.4329	31
32	0.04759	1.0050	29.540	134.14	2419.3	134.15	2425.7	2559.9	0.4644	8.4127	32
33	0.05034	1.0053	28.011	138.32	2420.7	138.33	2423.4	2561.7	0.4781	8.3927	33
34	0.05324	1.0056	26.571	142.50	2422.0	142.50	2421.0	2563.5	0.4917	8.3728	34
35	0.05628	1.0060	25.216	146.67	2423.4	146.68	2418.6	2565.3	0.5053	8.3531	35
36	0.05947	1.0063	23.940	150.85	2424.7	150.86	2416.2	2567.1	0.5188	8.3336	36
38	0.06632	1.0071	21.602	159.20	2427.4	159.21	2411.5	2570.7	0.5458	8.2950	38
40	0.07384	1.0078	19.523	167.56	2430.1	167.57	2406.7	2574.3	0.5725	8.2570	40
45	0.09593	1.0099	15.258	188.44	2436.8	188.45	2394.8	2583.2	0.6387	8.1648	45
50	.1235	1.0121	12.032	209.32	2443.5	209.33	2382.7	2592.1	.7038	8.0763	50
55	.1576	1.0146	9.568	230.21	2450.1	230.23	2370.7	2600.9	.7679	7.9913	55
60	.1994	1.0172	7.671	251.11	2456.6	251.13	2358.5	2609.6	.8312	7.9096	60
65	.2503	1.0199	6.197	272.02	2463.1	272.06	2346.2	2618.3	.8935	7.8310	65
70	.3119	1.0228	5.042	292.95	2469.6	292.98	2333.8	2626.8	.9549	7.7553	70
75	.3858	1.0259	4.131	313.90	2475.9	313.93	2321.4	2635.3	1.0155	7.6824	75
80	.4739	1.0291	3.407	334.86	2482.2	334.91	2308.8	2643.7	1.0753	7.6122	80
85	.5783	1.0325	2.828	355.84	2488.4	355.90	2296.0	2651.9	1.1343	7.5445	85
90	.7014	1.0360	2.361	376.85	2494.5	376.92	2283.2	2660.1	1.1925	7.4791	90
95	.8455	1.0397	1.982	397.88	2500.6	397.96	2270.2	2668.1	1.2500	7.4159	95
100	1.014	1.0435	1.673	418.94	2506.5	419.04	2257.0	2676.1	1.3069	7.3549	100
110	1.433	1.0516	1.210	461.14	2518.1	461.30	2230.2	2691.5	1.4185	7.2387	110
120	1.985	1.0603	0.8919	503.50	2529.3	503.71	2202.6	2706.3	1.5276	7.1296	120
130	2.701	1.0697	0.6685	546.02	2539.9	546.31	2174.2	2720.5	1.6344	7.0269	130
140	3.613	1.0797	0.5089	588.74	2550.0	589.13	2144.7	2733.9	1.7391	6.9299	140
150	4.758	1.0905	0.3928	631.68	2559.5	632.20	2114.3	2746.5	1.8418	6.8379	150
160	6.178	1.1020	0.3071	674.86	2568.4	675.55	2082.6	2758.1	1.9427	6.7502	160
170	7.917	1.1143	0.2428	718.33	2576.5	719.21	2049.5	2768.7	2.0419	6.6663	170
180	10.02	1.1274	0.1941	762.09	2583.7	763.22	2015.0	2778.2	2.1396	6.5857	180
190	12.54	1.1414	0.1565	806.19	2590.0	807.62	1978.8	2786.4	2.2359	6.5079	190
200	15.54	1.1565	0.1274	850.65	2595.3	852.45	1940.7	2793.2	2.3309	6.4323	200
210	19.06	1.1726	0.1044	895.53	2599.5	897.76	1900.7	2798.5	2.4248	6.3585	210
220	23.18	1.1900	0.08619	940.87	2602.4	943.62	1858.5	2802.1	2.5178	6.2861	220
230	27.95	1.2088	0.07158	986.74	2603.9	990.12	1813.8	2804.0	2.6099	6.2146	230
240	33.44	1.2291	0.05976	1033.2	2604.0	1037.3	1766.5	2803.8	2.7015	6.1437	240
250	39.73	1.2512	0.05013	1080.4	2602.4	1085.4	1716.2	2801.5	2.7927	6.0730	250
260	46.88	1.2755	0.04221	1128.4	2599.0	1134.4	1662.5	2796.6	2.8838	6.0019	260
270	54.99	1.3023	0.03564	1177.4	2593.7	1184.5	1605.2	2789.7	2.9751	5.9301	270
280	64.12	1.3321	0.03017	1227.5	2586.1	1236.0	1543.6	2779.6	3.0668	5.8571	280
290	74.36	1.3656	0.02557	1278.9	2576.0	1289.1	1477.1	2766.2	3.1594	5.7821	290
300	85.81	1.4036	0.02167	1332.0	2563.0	1344.0	1404.9	2749.0	3.2534	5.7045	300
320	112.7	1.4988	0.01549	1444.6	2525.5	1461.5	1238.6	2700.1	3.4480	5.5362	320
340	145.9	1.6379	0.01080	1570.3	2464.6	1594.2	1027.9	2622.0	3.6594	5.3357	340
360	186.5	1.8925	0.006945	1725.2	2351.5	1760.5	720.5	2481.0	3.9147	5.0526	360
374.14	220.9	3.155	0.003155	2029.6	2029.6	2099.3	0	2099.3	4.4298	4.4298	374.14

Source: Tables A-2 through A-5 are extracted from J. H. Keenan, F. G. Keyes, P. G. Hill, and J. G. Moore, *Steam Tables,* Wiley, New York, 1969.

Properties of Saturated Water (Liquid–Vapor): Pressure Table

H_2O

		Specific Volume m³/kg		Internal Energy kJ/kg		Enthalpy kJ/kg			Entropy kJ/kg · K		
Press. bar	Temp. °C	Sat. Liquid $v_f \times 10^3$	Sat. Vapor v_g	Sat. Liquid u_f	Sat. Vapor u_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Sat. Vapor s_g	Press. bar
0.04	28.96	1.0040	34.800	121.45	2415.2	121.46	2432.9	2554.4	0.4226	8.4746	0.04
0.06	36.16	1.0064	23.739	151.53	2425.0	151.53	2415.9	2567.4	0.5210	8.3304	0.06
0.08	41.51	1.0084	18.103	173.87	2432.2	173.88	2403.1	2577.0	0.5926	8.2287	0.08
0.10	45.81	1.0102	14.674	191.82	2437.9	191.83	2392.8	2584.7	0.6493	8.1502	0.10
0.20	60.06	1.0172	7.649	251.38	2456.7	251.40	2358.3	2609.7	0.8320	7.9085	0.20
0.30	69.10	1.0223	5.229	289.20	2468.4	289.23	2336.1	2625.3	0.9439	7.7686	0.30
0.40	75.87	1.0265	3.993	317.53	2477.0	317.58	2319.2	2636.8	1.0259	7.6700	0.40
0.50	81.33	1.0300	3.240	340.44	2483.9	340.49	2305.4	2645.9	1.0910	7.5939	0.50
0.60	85.94	1.0331	2.732	359.79	2489.6	359.86	2293.6	2653.5	1.1453	7.5320	0.60
0.70	89.95	1.0360	2.365	376.63	2494.5	376.70	2283.3	2660.0	1.1919	7.4797	0.70
0.80	93.50	1.0380	2.087	391.58	2498.8	391.66	2274.1	2665.8	1.2329	7.4346	0.80
0.90	96.71	1.0410	1.869	405.06	2502.6	405.15	2265.7	2670.9	1.2695	7.3949	0.90
1.00	99.63	1.0432	1.694	417.36	2506.1	417.46	2258.0	2675.5	1.3026	7.3594	1.00
1.50	111.4	1.0528	1.159	466.94	2519.7	467.11	2226.5	2693.6	1.4336	7.2233	1.50
2.00	120.2	1.0605	0.8857	504.49	2529.5	504.70	2201.9	2706.7	1.5301	7.1271	2.00
2.50	127.4	1.0672	0.7187	535.10	2537.2	535.37	2181.5	2716.9	1.6072	7.0527	2.50
3.00	133.6	1.0732	0.6058	561.15	2543.6	561.47	2163.8	2725.3	1.6718	6.9919	3.00
3.50	138.9	1.0786	0.5243	583.95	2546.9	584.33	2148.1	2732.4	1.7275	6.9405	3.50
4.00	143.6	1.0836	0.4625	604.31	2553.6	604.74	2133.8	2738.6	1.7766	6.8959	4.00
4.50	147.9	1.0882	0.4140	622.25	2557.6	623.25	2120.7	2743.9	1.8207	6.8565	4.50
5.00	151.9	1.0926	0.3749	639.68	2561.2	640.23	2108.5	2748.7	1.8607	6.8212	5.00
6.00	158.9	1.1006	0.3157	669.90	2567.4	670.56	2086.3	2756.8	1.9312	6.7600	6.00
7.00	165.0	1.1080	0.2729	696.44	2572.5	697.22	2066.3	2763.5	1.9922	6.7080	7.00
8.00	170.4	1.1148	0.2404	720.22	2576.8	721.11	2048.0	2769.1	2.0462	6.6628	8.00
9.00	175.4	1.1212	0.2150	741.83	2580.5	742.83	2031.1	2773.9	2.0946	6.6226	9.00
10.0	179.9	1.1273	0.1944	761.68	2583.6	762.81	2015.3	2778.1	2.1387	6.5863	10.0
15.0	198.3	1.1539	0.1318	843.16	2594.5	844.84	1947.3	2792.2	2.3150	6.4448	15.0
20.0	212.4	1.1767	0.09963	906.44	2600.3	908.79	1890.7	2799.5	2.4474	6.3409	20.0
25.0	224.0	1.1973	0.07998	959.11	2603.1	962.11	1841.0	2803.1	2.5547	6.2575	25.0
30.0	233.9	1.2165	0.06668	1004.8	2604.1	1008.4	1795.7	2804.2	2.6457	6.1869	30.0
35.0	242.6	1.2347	0.05707	1045.4	2603.7	1049.8	1753.7	2803.4	2.7253	6.1253	35.0
40.0	250.4	1.2522	0.04978	1082.3	2602.3	1087.3	1714.1	2801.4	2.7964	6.0701	40.0
45.0	257.5	1.2692	0.04406	1116.2	2600.1	1121.9	1676.4	2798.3	2.8610	6.0199	45.0
50.0	264.0	1.2859	0.03944	1147.8	2597.1	1154.2	1640.1	2794.3	2.9202	5.9734	50.0
60.0	275.6	1.3187	0.03244	1205.4	2589.7	1213.4	1571.0	2784.3	3.0267	5.8892	60.0
70.0	285.9	1.3513	0.02737	1257.6	2580.5	1267.0	1505.1	2772.1	3.1211	5.8133	70.0
80.0	295.1	1.3842	0.02352	1305.6	2569.8	1316.6	1441.3	2758.0	3.2068	5.7432	80.0
90.0	303.4	1.4178	0.02048	1350.5	2557.8	1363.3	1378.9	2742.1	3.2858	5.6772	90.0
100.	311.1	1.4524	0.01803	1393.0	2544.4	1407.6	1317.1	2724.7	3.3596	5.6141	100.
110.	318.2	1.4886	0.01599	1433.7	2529.8	1450.1	1255.5	2705.6	3.4295	5.5527	110.
120.	324.8	1.5267	0.01426	1473.0	2513.7	1491.3	1193.6	2684.9	3.4962	5.4924	120.
130.	330.9	1.5671	0.01278	1511.1	2496.1	1531.5	1130.7	2662.2	3.5606	5.4323	130.
140.	336.8	1.6107	0.01149	1548.6	2476.8	1571.1	1066.5	2637.6	3.6232	5.3717	140.
150.	342.2	1.6581	0.01034	1585.6	2455.5	1610.5	1000.0	2610.5	3.6848	5.3098	150.
160.	347.4	1.7107	0.009306	1622.7	2431.7	1650.1	930.6	2580.6	3.7461	5.2455	160.
170.	352.4	1.7702	0.008364	1660.2	2405.0	1690.3	856.9	2547.2	3.8079	5.1777	170.
180.	357.1	1.8397	0.007489	1698.9	2374.3	1732.0	777.1	2509.1	3.8715	5.1044	180.
190.	361.5	1.9243	0.006657	1739.9	2338.1	1776.5	688.0	2464.5	3.9388	5.0228	190.
200.	365.8	2.036	0.005834	1785.6	2293.0	1826.3	583.4	2409.7	4.0139	4.9269	200.
220.9	374.1	3.155	0.003155	2029.6	2029.6	2099.3	0	2099.3	4.4298	4.4298	220.9

H2O

ME 203 =7=

TABLE A-4 Properties of Superheated Water Vapor

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
	p = 0.06 bar = 0.006 MPa (T_{sat} = 36.16°C)				p = 0.35 bar = 0.035 MPa (T_{sat} = 72.69°C)			
Sat.	23.739	2425.0	2567.4	8.3304	4.526	2473.0	2631.4	7.7158
80	27.132	2487.3	2650.1	8.5804	4.625	2483.7	2645.6	7.7564
120	30.219	2544.7	2726.0	8.7840	5.163	2542.4	2723.1	7.9644
160	33.302	2602.7	2802.5	8.9693	5.696	2601.2	2800.6	8.1519
200	36.383	2661.4	2879.7	9.1398	6.228	2660.4	2878.4	8.3237
240	39.462	2721.0	2957.8	9.2982	6.758	2720.3	2956.8	8.4828
280	42.540	2781.5	3036.8	9.4464	7.287	2780.9	3036.0	8.6314
320	45.618	2843.0	3116.7	9.5859	7.815	2842.5	3116.1	8.7712
360	48.696	2905.5	3197.7	9.7180	8.344	2905.1	3197.1	8.9034
400	51.774	2969.0	3279.6	9.8435	8.872	2968.6	3279.2	9.0291
440	54.851	3033.5	3362.6	9.9633	9.400	3033.2	3362.2	9.1490
500	59.467	3132.3	3489.1	10.1336	10.192	3132.1	3488.8	9.3194
	p = 0.70 bar = 0.07 MPa (T_{sat} = 89.95°C)				p = 1.0 bar = 0.10 MPa (T_{sat} = 99.63°C)			
Sat.	2.365	2494.5	2660.0	7.4797	1.694	2506.1	2675.5	7.3594
100	2.434	2509.7	2680.0	7.5341	1.696	2506.7	2676.2	7.3614
120	2.571	2539.7	2719.6	7.6375	1.793	2537.3	2716.6	7.4668
160	2.841	2599.4	2798.2	7.8279	1.984	2597.8	2796.2	7.6597
200	3.108	2659.1	2876.7	8.0012	2.172	2658.1	2875.3	7.8343
240	3.374	2719.3	2955.5	8.1611	2.359	2718.5	2954.5	7.9949
280	3.640	2780.2	3035.0	8.3162	2.546	2779.6	3034.2	8.1445
320	3.905	2842.0	3115.3	8.4504	2.732	2841.5	3114.6	8.2849
360	4.170	2904.6	3196.5	8.5828	2.917	2904.2	3195.9	8.4175
400	4.434	2968.2	3278.6	8.7086	3.103	2967.9	3278.2	8.5435
440	4.698	3032.9	3361.8	8.8286	3.288	3032.6	3361.4	8.6636
500	5.095	3131.8	3488.5	8.9991	3.565	3131.6	3488.1	8.8342
	p = 1.5 bar = 0.15 MPa (T_{sat} = 111.37°C)				p = 3.0 bar = 0.30 MPa (T_{sat} = 133.55°C)			
Sat.	1.159	2519.7	2693.6	7.2233	0.606	2543.6	2725.3	6.9919
120	1.188	2533.3	2711.4	7.2693				
160	1.317	2595.2	2792.8	7.4665	0.651	2587.1	2782.3	7.1276
200	1.444	2656.2	2872.9	7.6433	0.716	2650.7	2865.5	7.3115
240	1.570	2717.2	2952.7	7.8052	0.781	2713.1	2947.3	7.4774
280	1.695	2778.6	3032.8	7.9555	0.844	2775.4	3028.6	7.6299
320	1.819	2840.6	3113.5	8.0964	0.907	2838.1	3110.1	7.7722
360	1.943	2903.5	3195.0	8.2293	0.969	2901.4	3192.2	7.9061
400	2.067	2967.3	3277.4	8.3555	1.032	2965.6	3275.0	8.0330
440	2.191	3032.1	3360.7	8.4757	1.094	3030.6	3358.7	8.1538
500	2.376	3131.2	3487.6	8.6466	1.187	3130.0	3486.0	8.3251
600	2.685	3301.7	3704.3	8.9101	1.341	3300.8	3703.2	8.5892
	p = 5.0 bar = 0.50 MPa (T_{sat} = 151.86°C)				p = 7.0 bar = 0.70 MPa (T_{sat} = 164.97°C)			
Sat.	0.3749	2561.2	2748.7	6.8213	0.2729	2572.5	2763.5	6.7080
180	0.4045	2609.7	2812.0	6.9656	0.2847	2599.8	2799.1	6.7880
200	0.4249	2642.9	2855.4	7.0592	0.2999	2634.8	2844.8	6.8865
240	0.4646	2707.6	2939.9	7.2307	0.3292	2701.8	2932.2	7.0641
280	0.5034	2771.2	3022.9	7.3865	0.3574	2766.9	3017.1	7.2233
320	0.5416	2834.7	3105.6	7.5308	0.3852	2831.3	3100.9	7.3697
360	0.5796	2898.7	3188.4	7.6660	0.4126	2895.8	3184.7	7.5063
400	0.6173	2963.2	3271.9	7.7938	0.4397	2960.9	3268.7	7.6350
440	0.6548	3028.6	3356.0	7.9152	0.4667	3026.6	3353.3	7.7571
500	0.7109	3128.4	3483.9	8.0873	0.5070	3126.8	3481.7	7.9299
600	0.8041	3299.6	3701.7	8.3522	0.5738	3298.5	3700.2	8.1956
700	0.8969	3477.5	3925.9	8.5952	0.6403	3476.6	3924.8	8.4391
	p = 10.0 bar = 1.0 MPa (T_{sat} = 179.91°C)				p = 15.0 bar = 1.5 MPa (T_{sat} = 198.32°C)			
Sat.	0.1944	2583.6	2778.1	6.5865	0.1318	2594.5	2792.2	6.4448
200	0.2060	2621.9	2827.9	6.6940	0.1325	2598.1	2796.8	6.4546
240	0.2275	2692.9	2920.4	6.8817	0.1483	2676.9	2899.3	6.6628
280	0.2480	2760.2	3008.2	7.0465	0.1627	2748.6	2992.7	6.8381
320	0.2678	2826.1	3093.9	7.1962	0.1765	2817.1	3081.9	6.9938
360	0.2873	2891.6	3178.9	7.3349	0.1899	2884.4	3169.2	7.1363
400	0.3066	2957.3	3263.9	7.4651	0.2030	2951.3	3255.8	7.2690
440	0.3257	3023.6	3349.3	7.5883	0.2160	3018.5	3342.5	7.3940
500	0.3541	3124.4	3478.5	7.7622	0.2352	3120.3	3473.1	7.5698
540	0.3729	3192.6	3565.6	7.8720	0.2478	3189.1	3560.9	7.6805
600	0.4011	3296.8	3697.9	8.0290	0.2668	3293.9	3694.0	7.8385
640	0.4198	3367.4	3787.2	8.1290	0.2793	3364.8	3783.8	7.9391

H_2O

H_2O

ME 203 =8=

TABLE A-4 (Continued)

H_2O

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
	p = 20.0 bar = 2.0 MPa (T_{sat} = 212.42°C)				p = 30.0 bar = 3.0 MPa (T_{sat} = 233.90°C)			
Sat.	0.0996	2600.3	2799.5	6.3409	0.0667	2604.1	2804.2	6.1869
240	0.1085	2659.6	2876.5	6.4952	0.0682	2619.7	2824.3	6.2265
280	0.1200	2736.4	2976.4	6.6828	0.0771	2709.9	2941.3	6.4462
320	0.1308	2807.9	3069.5	6.8452	0.0850	2788.4	3043.4	6.6245
360	0.1411	2877.0	3159.3	6.9917	0.0923	2861.7	3138.7	6.7801
400	0.1512	2945.2	3247.6	7.1271	0.0994	2932.8	3230.9	6.9212
440	0.1611	3013.4	3335.5	7.2540	0.1062	3002.9	3321.5	7.0520
500	0.1757	3116.2	3467.6	7.4317	0.1162	3108.0	3456.5	7.2338
540	0.1853	3185.6	3556.1	7.5434	0.1227	3178.4	3546.6	7.3474
600	0.1996	3290.9	3690.1	7.7024	0.1324	3285.0	3682.3	7.5085
640	0.2091	3362.2	3780.4	7.8035	0.1388	3357.0	3773.5	7.6106
700	0.2232	3470.9	3917.4	7.9487	0.1484	3466.5	3911.7	7.7571
	p = 40 bar = 4.0 MPa (T_{sat} = 250.4°C)				p = 60 bar = 6.0 MPa (T_{sat} = 275.64°C)			
Sat.	0.04978	2602.3	2801.4	6.0701	0.03244	2589.7	2784.3	5.8892
280	0.05546	2680.0	2901.8	6.2568	0.03317	2605.2	2804.2	5.9252
320	0.06199	2767.4	3015.4	6.4553	0.03876	2720.0	2952.6	6.1846
360	0.06788	2845.7	3117.2	6.6215	0.04331	2811.2	3071.1	6.3782
400	0.07341	2919.9	3213.6	6.7690	0.04739	2892.9	3177.2	6.5408
440	0.07872	2992.2	3307.1	6.9041	0.05122	2970.0	3277.3	6.6853
500	0.08643	3099.5	3445.3	7.0901	0.05665	3082.2	3422.2	6.8803
540	0.09145	3171.1	3536.9	7.2056	0.06015	3156.1	3517.0	6.9999
600	0.09885	3279.1	3674.4	7.3688	0.06525	3266.9	3658.4	7.1677
640	0.1037	3351.8	3766.6	7.4720	0.06859	3341.0	3752.6	7.2731
700	0.1110	3462.1	3905.9	7.6198	0.07352	3453.1	3894.1	7.4234
740	0.1157	3536.6	3999.6	7.7141	0.07677	3528.3	3989.2	7.5190
	p = 80 bar = 8.0 MPa (T_{sat} = 295.06°C)				p = 100 bar = 10.0 MPa (T_{sat} = 311.06°C)			
Sat.	0.02352	2569.8	2758.0	5.7432	0.01803	2544.4	2724.7	5.6141
320	0.02682	2662.7	2877.2	5.9489	0.01925	2588.8	2781.3	5.7103
360	0.03089	2772.7	3019.8	6.1819	0.02331	2729.1	2962.1	6.0060
400	0.03432	2863.8	3138.3	6.3634	0.02641	2832.4	3096.5	6.2120
440	0.03742	2946.7	3246.1	6.5190	0.02911	2922.1	3213.2	6.3805
480	0.04034	3025.7	3348.4	6.6586	0.03160	3005.4	3321.4	6.5282
520	0.04313	3102.7	3447.7	6.7871	0.03394	3085.6	3425.1	6.6622
560	0.04582	3178.7	3545.3	6.9072	0.03619	3164.1	3526.0	6.7864
600	0.04845	3254.4	3642.0	7.0206	0.03837	3241.7	3625.3	6.9029
640	0.05102	3330.1	3738.3	7.1283	0.04048	3318.9	3723.7	7.0131
700	0.05481	3443.9	3882.4	7.2812	0.04358	3434.7	3870.5	7.1687
740	0.05729	3520.4	3978.7	7.3782	0.04560	3512.1	3968.1	7.2670
	p = 120 bar = 12.0 MPa (T_{sat} = 324.75°C)				p = 140 bar = 14.0 MPa (T_{sat} = 336.75°C)			
Sat.	0.01426	2513.7	2684.9	5.4924	0.01149	2476.8	2637.6	5.3717
360	0.01811	2678.4	2895.7	5.8361	0.01422	2617.4	2816.5	5.6602
400	0.02108	2798.3	3051.3	6.0747	0.01722	2760.9	3001.9	5.9448
440	0.02355	2896.1	3178.7	6.2586	0.01954	2868.6	3142.2	6.1474
480	0.02576	2984.4	3293.5	6.4154	0.02157	2962.5	3264.5	6.3143
520	0.02781	3068.0	3401.8	6.5555	0.02343	3049.8	3377.8	6.4610
560	0.02977	3149.0	3506.2	6.6840	0.02517	3133.6	3486.0	6.5941
600	0.03164	3228.7	3608.3	6.8037	0.02683	3215.4	3591.1	6.7172
640	0.03345	3307.5	3709.0	6.9164	0.02843	3296.0	3694.1	6.8326
700	0.03610	3425.2	3858.4	7.0749	0.03075	3415.7	3846.2	6.9939
740	0.03781	3503.7	3957.4	7.1746	0.03225	3495.2	3946.7	7.0952

R-134a

Properties of Saturated Refrigerant 134a (Liquid–Vapor): Temperature Table

Temp. °C	Press. bar	Specific Volume m³/kg Sat. Liquid $v_f \times 10^3$	Sat. Vapor v_g	Internal Energy kJ/kg Sat. Liquid u_f	Sat. Vapor u_g	Enthalpy kJ/kg Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Entropy kJ/kg · K Sat. Liquid s_f	Sat. Vapor s_g	Temp. °C
−40	0.5164	0.7055	0.3569	−0.04	204.45	0.00	222.88	222.88	0.0000	0.9560	−40
−36	0.6332	0.7113	0.2947	4.68	206.73	4.73	220.67	225.40	0.0201	0.9506	−36
−32	0.7704	0.7172	0.2451	9.47	209.01	9.52	218.37	227.90	0.0401	0.9456	−32
−28	0.9305	0.7233	0.2052	14.31	211.29	14.37	216.01	230.38	0.0600	0.9411	−28
−26	1.0199	0.7265	0.1882	16.75	212.43	16.82	214.80	231.62	0.0699	0.9390	−26
−24	1.1160	0.7296	0.1728	19.21	213.57	19.29	213.57	232.85	0.0798	0.9370	−24
−22	1.2192	0.7328	0.1590	21.68	214.70	21.77	212.32	234.08	0.0897	0.9351	−22
−20	1.3299	0.7361	0.1464	24.17	215.84	24.26	211.05	235.31	0.0996	0.9332	−20
−18	1.4483	0.7395	0.1350	26.67	216.97	26.77	209.76	236.53	0.1094	0.9315	−18
−16	1.5748	0.7428	0.1247	29.18	218.10	29.30	208.45	237.74	0.1192	0.9298	−16
−12	1.8540	0.7498	0.1068	34.25	220.36	34.39	205.77	240.15	0.1388	0.9267	−12
−8	2.1704	0.7569	0.0919	39.38	222.60	39.54	203.00	242.54	0.1583	0.9239	−8
−4	2.5274	0.7644	0.0794	44.56	224.84	44.75	200.15	244.90	0.1777	0.9213	−4
0	2.9282	0.7721	0.0689	49.79	227.06	50.02	197.21	247.23	0.1970	0.9190	0
4	3.3765	0.7801	0.0600	55.08	229.27	55.35	194.19	249.53	0.2162	0.9169	4
8	3.8756	0.7884	0.0525	60.43	231.46	60.73	191.07	251.80	0.2354	0.9150	8
12	4.4294	0.7971	0.0460	65.83	233.63	66.18	187.85	254.03	0.2545	0.9132	12
16	5.0416	0.8062	0.0405	71.29	235.78	71.69	184.52	256.22	0.2735	0.9116	16
20	5.7160	0.8157	0.0358	76.80	237.91	77.26	181.09	258.36	0.2924	0.9102	20
24	6.4566	0.8257	0.0317	82.37	240.01	82.90	177.55	260.45	0.3113	0.9089	24
26	6.8530	0.8309	0.0298	85.18	241.05	85.75	175.73	261.48	0.3208	0.9082	26
28	7.2675	0.8362	0.0281	88.00	242.08	88.61	173.89	262.50	0.3302	0.9076	28
30	7.7006	0.8417	0.0265	90.84	243.10	91.49	172.00	263.50	0.3396	0.9070	30
32	8.1528	0.8473	0.0250	93.70	244.12	94.39	170.09	264.48	0.3490	0.9064	32
34	8.6247	0.8530	0.0236	96.58	245.12	97.31	168.14	265.45	0.3584	0.9058	34
36	9.1168	0.8590	0.0223	99.47	246.11	100.25	166.15	266.40	0.3678	0.9053	36
38	9.6298	0.8651	0.0210	102.38	247.09	103.21	164.12	267.33	0.3772	0.9047	38
40	10.164	0.8714	0.0199	105.30	248.06	106.19	162.05	268.24	0.3866	0.9041	40
42	10.720	0.8780	0.0188	108.25	249.02	109.19	159.94	269.14	0.3960	0.9035	42
44	11.299	0.8847	0.0177	111.22	249.96	112.22	157.79	270.01	0.4054	0.9030	44
48	12.526	0.8989	0.0159	117.22	251.79	118.35	153.33	271.68	0.4243	0.9017	48
52	13.851	0.9142	0.0142	123.31	253.55	124.58	148.66	273.24	0.4432	0.9004	52
56	15.278	0.9308	0.0127	129.51	255.23	130.93	143.75	274.68	0.4622	0.8990	56
60	16.813	0.9488	0.0114	135.82	256.81	137.42	138.57	275.99	0.4814	0.8973	60
70	21.162	1.0027	0.0086	152.22	260.15	154.34	124.08	278.43	0.5302	0.8918	70
80	26.324	1.0766	0.0064	169.88	262.14	172.71	106.41	279.12	0.5814	0.8827	80
90	32.435	1.1949	0.0046	189.82	261.34	193.69	82.63	276.32	0.6380	0.8655	90
100	39.742	1.5443	0.0027	218.60	248.49	224.74	34.40	259.13	0.7196	0.8117	100

Source: Tables A-10 through A-12 are calculated based on equations from D. P. Wilson and R. S. Basu, "Thermodynamic Properties of a New Stratospherically Safe Working Fluid—Refrigerant 134a," *ASHRAE Trans.*, Vol. 94, Pt. 2, 1988, pp. 2095–2118.

Properties of Saturated Refrigerant 134a (Liquid–Vapor): Pressure Table

Press. bar	Temp. °C	Specific Volume m³/kg Sat. Liquid $v_f \times 10^3$	Sat. Vapor v_g	Internal Energy kJ/kg Sat. Liquid u_f	Sat. Vapor u_g	Enthalpy kJ/kg Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Entropy kJ/kg · K Sat. Liquid s_f	Sat. Vapor s_g	Press. bar
0.6	−37.07	0.7097	0.3100	3.41	206.12	3.46	221.27	224.72	0.0147	0.9520	0.6
0.8	−31.21	0.7184	0.2366	10.41	209.46	10.47	217.92	228.39	0.0440	0.9447	0.8
1.0	−26.43	0.7258	0.1917	16.22	212.18	16.29	215.06	231.35	0.0678	0.9395	1.0
1.2	−22.36	0.7323	0.1614	21.23	214.50	21.32	212.54	233.86	0.0879	0.9354	1.2
1.4	−18.80	0.7381	0.1395	25.66	216.52	25.77	210.27	236.04	0.1055	0.9322	1.4
1.6	−15.62	0.7435	0.1229	29.66	218.32	29.78	208.19	237.97	0.1211	0.9295	1.6
1.8	−12.73	0.7485	0.1098	33.31	219.94	33.45	206.26	239.71	0.1352	0.9273	1.8
2.0	−10.09	0.7532	0.0993	36.69	221.43	36.84	204.46	241.30	0.1481	0.9253	2.0
2.4	−5.37	0.7618	0.0834	42.77	224.07	42.95	201.14	244.09	0.1710	0.9222	2.4
2.8	−1.23	0.7697	0.0719	48.18	226.38	48.39	198.13	246.52	0.1911	0.9197	2.8
3.2	2.48	0.7770	0.0632	53.06	228.43	53.31	195.35	248.66	0.2089	0.9177	3.2
3.6	5.84	0.7839	0.0564	57.54	230.28	57.82	192.76	250.58	0.2251	0.9160	3.6
4.0	8.93	0.7904	0.0509	61.69	231.97	62.00	190.32	252.32	0.2399	0.9145	4.0
5.0	15.74	0.8056	0.0409	70.93	235.64	71.33	184.74	256.07	0.2723	0.9117	5.0
6.0	21.58	0.8196	0.0341	78.99	238.74	79.48	179.71	259.19	0.2999	0.9097	6.0
7.0	26.72	0.8328	0.0292	86.19	241.42	86.78	175.07	261.85	0.3242	0.9080	7.0
8.0	31.33	0.8454	0.0255	92.75	243.78	93.42	170.73	264.15	0.3459	0.9066	8.0
9.0	35.53	0.8576	0.0226	98.79	245.88	99.56	166.62	266.18	0.3656	0.9054	9.0
10.0	39.39	0.8695	0.0202	104.42	247.77	105.29	162.68	267.97	0.3838	0.9043	10.0
12.0	46.32	0.8928	0.0166	114.69	251.03	115.76	155.23	270.99	0.4164	0.9023	12.0
14.0	52.43	0.9159	0.0140	123.98	253.74	125.26	148.14	273.40	0.4453	0.9003	14.0
16.0	57.92	0.9392	0.0121	132.52	256.00	134.02	141.31	275.33	0.4714	0.8982	16.0
18.0	62.91	0.9631	0.0105	140.49	257.88	142.22	134.60	276.83	0.4954	0.8959	18.0
20.0	67.49	0.9878	0.0093	148.02	259.41	149.99	127.95	277.94	0.5178	0.8934	20.0
25.0	77.59	1.0562	0.0069	165.48	261.84	168.12	111.06	279.17	0.5687	0.8854	25.0
30.0	86.22	1.1416	0.0053	181.88	262.16	185.30	92.71	278.01	0.6156	0.8735	30.0

R-134a

R-134a

Properties of Superheated Refrigerant 134a Vapor

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
	p = 0.6 bar = 0.06 MPa (T_{sat} = −37.07°C)				p = 1.0 bar = 0.10 MPa (T_{sat} = −26.43°C)			
Sat.	0.31003	206.12	224.72	0.9520	0.19170	212.18	231.35	0.9395
−20	0.33536	217.86	237.98	1.0062	0.19770	216.77	236.54	0.9602
−10	0.34992	224.97	245.96	1.0371	0.20686	224.01	244.70	0.9918
0	0.36433	232.24	254.10	1.0675	0.21587	231.41	252.99	1.0227
10	0.37861	239.69	262.41	1.0973	0.22473	238.96	261.43	1.0531
20	0.39279	247.32	270.89	1.1267	0.23349	246.67	270.02	1.0829
30	0.40688	255.12	279.53	1.1557	0.24216	254.54	278.76	1.1122
40	0.42091	263.10	288.35	1.1844	0.25076	262.58	287.66	1.1411
50	0.43487	271.25	297.34	1.2126	0.25930	270.79	296.72	1.1696
60	0.44879	279.58	306.51	1.2405	0.26779	279.16	305.94	1.1977
70	0.46266	288.08	315.84	1.2681	0.27623	287.70	315.32	1.2254
80	0.47650	296.75	325.34	1.2954	0.28464	296.40	324.87	1.2528
90	0.49031	305.58	335.00	1.3224	0.29302	305.27	334.57	1.2799
	p = 1.4 bar = 0.14 MPa (T_{sat} = −18.80°C)				p = 1.8 bar = 0.18 MPa (T_{sat} = −12.73°C)			
Sat.	0.13945	216.52	236.04	0.9322	0.10983	219.94	239.71	0.9273
−10	0.14549	223.03	243.40	0.9606	0.11135	222.02	242.06	0.9362
0	0.15219	230.55	251.86	0.9922	0.11678	229.67	250.69	0.9684
10	0.15875	238.21	260.43	1.0230	0.12207	237.44	259.41	0.9998
20	0.16520	246.01	269.13	1.0532	0.12723	245.33	268.23	1.0304
30	0.17155	253.96	277.97	1.0828	0.13230	253.36	277.17	1.0604
40	0.17783	262.06	286.96	1.1120	0.13730	261.53	286.24	1.0898
50	0.18404	270.32	296.09	1.1407	0.14222	269.85	295.45	1.1187
60	0.19020	278.74	305.37	1.1690	0.14710	278.31	304.79	1.1472
70	0.19633	287.32	314.80	1.1969	0.15193	286.93	314.28	1.1753
80	0.20241	296.06	324.39	1.2244	0.15672	295.71	323.92	1.2030
90	0.20846	304.95	334.14	1.2516	0.16148	304.63	333.70	1.2303
100	0.21449	314.01	344.04	1.2785	0.16622	313.72	343.63	1.2573
	p = 2.0 bar = 0.20 MPa (T_{sat} = −10.09°C)				p = 2.4 bar = 0.24 MPa (T_{sat} = −5.37°C)			
Sat.	0.09933	221.43	241.30	0.9253	0.08343	224.07	244.09	0.9222
−10	0.09938	221.50	241.38	0.9256				
0	0.10438	229.23	250.10	0.9582	0.08574	228.31	248.89	0.9399
10	0.10922	237.05	258.89	0.9898	0.08993	236.26	257.84	0.9721
20	0.11394	244.99	267.78	1.0206	0.09399	244.30	266.85	1.0034
30	0.11856	253.06	276.77	1.0508	0.09794	252.45	275.95	1.0339
40	0.12311	261.26	285.88	1.0804	0.10181	260.72	285.16	1.0637
50	0.12758	269.61	295.12	1.1094	0.10562	269.12	294.47	1.0930
60	0.13201	278.10	304.50	1.1380	0.10937	277.67	303.91	1.1218
70	0.13639	286.74	314.02	1.1661	0.11307	286.35	313.49	1.1501
80	0.14073	295.53	323.68	1.1939	0.11674	295.18	323.19	1.1780
90	0.14504	304.47	333.48	1.2212	0.12037	304.15	333.04	1.2055
100	0.14932	313.57	343.43	1.2483	0.12398	313.27	343.03	1.2326

(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
	p = 2.8 bar = 0.28 MPa (T_{sat} = −1.23°C)				p = 3.2 bar = 0.32 MPa (T_{sat} = 2.48°C)			
Sat.	0.07193	226.38	246.52	0.9197	0.06322	228.43	248.66	0.9177
0	0.07240	227.37	247.64	0.9238				
10	0.07613	235.44	256.76	0.9566	0.06576	234.61	255.65	0.9427
20	0.07972	243.59	265.91	0.9883	0.06901	242.87	264.95	0.9749
30	0.08320	251.83	275.12	1.0192	0.07214	251.19	274.28	1.0062
40	0.08660	260.17	284.42	1.0494	0.07518	259.61	283.67	1.0367
50	0.08992	268.64	293.81	1.0789	0.07815	268.14	293.15	1.0665
60	0.09319	277.23	303.32	1.1079	0.08106	276.79	302.72	1.0957
70	0.09641	285.96	312.95	1.1364	0.08392	285.56	312.41	1.1243
80	0.09960	294.82	322.71	1.1644	0.08674	294.46	322.22	1.1525
90	0.10275	303.83	332.60	1.1920	0.08953	303.50	332.15	1.1802
100	0.10587	312.98	342.62	1.2193	0.09229	312.68	342.21	1.2076
110	0.10897	322.27	352.78	1.2461	0.09503	322.00	352.40	1.2345
120	0.11205	331.71	363.08	1.2727	0.09774	331.45	362.73	1.2611
	p = 4.0 bar = 0.40 MPa (T_{sat} = 8.93°C)				p = 5.0 bar = 0.50 MPa (T_{sat} = 15.74°C)			
Sat.	0.05089	231.97	252.32	0.9145	0.04086	235.64	256.07	0.9117
10	0.05119	232.87	253.35	0.9182				
20	0.05397	241.37	262.96	0.9515	0.04188	239.40	260.34	0.9264
30	0.05662	249.89	272.54	0.9837	0.04416	248.20	270.28	0.9597
40	0.05917	258.47	282.14	1.0148	0.04633	256.99	280.16	0.9918
50	0.06164	267.13	291.79	1.0452	0.04842	265.83	290.04	1.0229
60	0.06405	275.89	301.51	1.0748	0.05043	274.73	299.95	1.0531
70	0.06641	284.75	311.32	1.1038	0.05240	283.72	309.92	1.0825
80	0.06873	293.73	321.23	1.1322	0.05432	292.80	319.96	1.1114
90	0.07102	302.84	331.25	1.1602	0.05620	302.00	330.10	1.1397
100	0.07327	312.07	341.38	1.1878	0.05805	311.31	340.33	1.1675
110	0.07550	321.44	351.64	1.2149	0.05988	320.74	350.68	1.1949
120	0.07771	330.94	362.03	1.2417	0.06168	330.30	361.14	1.2218
130	0.07991	340.58	372.54	1.2681	0.06347	339.98	371.72	1.2484
140	0.08208	350.35	383.18	1.2941	0.06524	349.79	382.42	1.2746

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
	p = 6.0 bar = 0.60 MPa (T_{sat} = 21.58°C)				p = 7.0 bar = 0.70 MPa (T_{sat} = 26.72°C)			
Sat.	0.03408	238.74	259.19	0.9097	0.02918	241.42	261.85	0.9080
30	0.03581	246.41	267.89	0.9388	0.02979	244.51	265.37	0.9197
40	0.03774	255.45	278.09	0.9719	0.03157	253.83	275.93	0.9539
50	0.03958	264.48	288.23	1.0037	0.03324	263.08	286.35	0.9867
60	0.04134	273.54	298.35	1.0346	0.03482	272.31	296.69	1.0182
70	0.04304	282.66	308.48	1.0645	0.03634	281.57	307.01	1.0487
80	0.04469	291.86	318.67	1.0938	0.03781	290.88	317.35	1.0784
90	0.04631	301.14	328.93	1.1225	0.03924	300.27	327.74	1.1074
100	0.04790	310.53	339.27	1.1505	0.04064	309.74	338.19	1.1358
110	0.04946	320.03	349.70	1.1781	0.04201	319.31	348.71	1.1637
120	0.05099	329.64	360.24	1.2053	0.04335	328.98	359.33	1.1910
130	0.05251	339.38	370.88	1.2320	0.04468	338.76	370.04	1.2179
140	0.05402	349.23	381.64	1.2584	0.04599	348.66	380.86	1.2444
150	0.05550	359.21	392.52	1.2844	0.04729	358.68	391.79	1.2706
160	0.05698	369.32	403.51	1.3100	0.04857	368.82	402.82	1.2963

(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
	p = 8.0 bar = 0.80 MPa (T_{sat} = 31.33°C)				p = 9.0 bar = 0.90 MPa (T_{sat} = 35.53°C)			
Sat.	0.02547	243.78	264.15	0.9066	0.02255	245.88	266.18	0.9054
40	0.02691	252.13	273.66	0.9374	0.02325	250.32	271.25	0.9217
50	0.02846	261.62	284.39	0.9711	0.02472	260.09	282.34	0.9566
60	0.02992	271.04	294.98	1.0034	0.02609	269.72	293.21	0.9897
70	0.03131	280.45	305.50	1.0345	0.02738	279.30	303.94	1.0214
80	0.03264	289.89	316.00	1.0647	0.02861	288.87	314.62	1.0521
90	0.03393	299.37	326.52	1.0940	0.02980	298.46	325.28	1.0819
100	0.03519	308.93	337.08	1.1227	0.03095	308.11	335.96	1.1109
110	0.03642	318.57	347.71	1.1508	0.03207	317.82	346.68	1.1392
120	0.03762	328.31	358.40	1.1784	0.03316	327.62	357.47	1.1670
130	0.03881	338.14	369.19	1.2055	0.03423	337.52	368.33	1.1943
140	0.03997	348.09	380.07	1.2321	0.03529	347.51	379.27	1.2211
150	0.04113	358.15	391.05	1.2584	0.03633	357.61	390.31	1.2475
160	0.04227	368.32	402.14	1.2843	0.03736	367.82	401.44	1.2735
170	0.04340	378.61	413.33	1.3098	0.03838	378.14	412.68	1.2992
180	0.04452	389.02	424.63	1.3351	0.03939	388.57	424.02	1.3245

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
	p = 10.0 bar = 1.00 MPa (T_{sat} = 39.39°C)				p = 12.0 bar = 1.20 MPa (T_{sat} = 46.32°C)			
Sat.	0.02020	247.77	267.97	0.9043	0.01663	251.03	270.99	0.9023
40	0.02029	248.39	268.68	0.9066				
50	0.02171	258.48	280.19	0.9428	0.01712	254.98	275.52	0.9164
60	0.02301	268.35	291.36	0.9768	0.01835	265.42	287.44	0.9527
70	0.02423	278.11	302.34	1.0093	0.01947	275.59	298.96	0.9868
80	0.02538	287.82	313.20	1.0405	0.02051	285.62	310.24	1.0192
90	0.02649	297.53	324.01	1.0707	0.02150	295.59	321.39	1.0503
100	0.02755	307.27	334.82	1.1000	0.02244	305.54	332.47	1.0804
110	0.02858	317.06	345.65	1.1286	0.02335	315.50	343.52	1.1096
120	0.02959	326.93	356.52	1.1567	0.02423	325.51	354.58	1.1381
130	0.03058	336.88	367.46	1.1841	0.02508	335.58	365.68	1.1660
140	0.03154	346.92	378.46	1.2111	0.02592	345.73	376.83	1.1933
150	0.03250	357.06	389.56	1.2376	0.02674	355.95	388.04	1.2201
160	0.03344	367.31	400.74	1.2638	0.02754	366.27	399.33	1.2465
170	0.03436	377.66	412.02	1.2895	0.02834	376.69	410.70	1.2724
180	0.03528	388.12	423.40	1.3149	0.02912	387.21	422.16	1.2980

R-134a

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
	p = 14.0 bar = 1.40 MPa (T_{sat} = 52.43°C)				p = 16.0 bar = 1.60 MPa (T_{sat} = 57.92°C)			
Sat.	0.01405	253.74	273.40	0.9003	0.01208	256.00	275.33	0.8982
60	0.01495	262.17	283.10	0.9297	0.01233	258.48	278.20	0.9069
70	0.01603	272.87	295.31	0.9658	0.01340	269.89	291.33	0.9457
80	0.01701	283.29	307.10	0.9997	0.01435	280.78	303.74	0.9813
90	0.01792	293.55	318.63	1.0319	0.01521	291.39	315.72	1.0148
100	0.01878	303.73	330.02	1.0628	0.01601	301.84	327.46	1.0467
110	0.01960	313.88	341.32	1.0927	0.01677	312.20	339.04	1.0773
120	0.02039	324.05	352.59	1.1218	0.01750	322.53	350.53	1.1069
130	0.02115	334.25	363.86	1.1501	0.01820	332.87	361.99	1.1357
140	0.02189	344.50	375.15	1.1777	0.01887	343.24	373.44	1.1638
150	0.02262	354.82	386.49	1.2048	0.01953	353.66	384.91	1.1912
160	0.02333	365.22	397.89	1.2315	0.02017	364.15	396.43	1.2181
170	0.02403	375.71	409.36	1.2576	0.02080	374.71	407.99	1.2445
180	0.02472	386.29	420.90	1.2834	0.02142	385.35	419.62	1.2704
190	0.02541	396.96	432.53	1.3088	0.02203	396.08	431.33	1.2960
200	0.02608	407.73	444.24	1.3338	0.02263	406.90	443.11	1.3212

L-2/T-1/ME **Date: 16/07/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2016-2017

Sub: **MATH 261** (Matrices, Vectors Calculus, Series Solution and Laplace Transforms)

Full Marks: 280 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

SECTION – A

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

1. (a) Solve the following system of linear equations by using Gaussian elimination: **($15\frac{2}{3}$)**

$$\begin{aligned} &x_1 + 3x_2 - 2x_3 + 2x_5 = 0 \\ &2x_1 + 6x_2 - 5x_3 - 2x_4 + 4x_5 - 3x_6 = 0 \\ &5x_3 + 10x_4 + 15x_6 = 0 \\ &2x_1 + 6x_2 + 8x_4 + 4x_5 + 18x_6 = 0 \end{aligned}$$

(b) Find the inverse of the following matrix A by any suitable method. **(15)**

$$A = \begin{bmatrix} 1 & -1 & 2 & 1 \\ 3 & 0 & 2 & 2 \\ 2 & 1 & -1 & 1 \\ 1 & 0 & 1 & 1 \end{bmatrix}$$

(c) Reduce the matrix A to its normal form and hence find the rank. **(16)**

$$A = \begin{bmatrix} 3 & 4 & 5 & 6 & 7 \\ 4 & 5 & 6 & 7 & 8 \\ 5 & 6 & 7 & 8 & 9 \\ 10 & 11 & 12 & 13 & 14 \\ 15 & 16 & 17 & 18 & 19 \end{bmatrix}$$

2. (a) State Cayley-Hamilton theorem. Show that the matrix **($20\frac{2}{3}$)**

$A = \begin{bmatrix} 3 & -1 & 1 \\ 7 & -5 & 1 \\ 6 & -6 & 2 \end{bmatrix}$ satisfies the Cayley-Hamilton theorem and hence find A^{-1}.

(b) Find eigen values and corresponding eigen vectors of the matrix **(26)**

$A = \begin{bmatrix} 2 & 0 & 0 \\ -1 & 1 & 0 \\ 1 & -4 & 0 \end{bmatrix}$. Also show that A is diagonalizable and hence compute A^7.

Contd P/2

3. (a) Find the equation of the tangent plane and normal line to the surface $xz^2 + x^2y = z - 1$ at the point (1,-3,2). **($15\frac{2}{3}$)**

(b) If $\mathbf{F} = xy\mathbf{i} + (x^2 + y^2)\mathbf{j}$ and C is the rectangle in xy-plane bounded by the lines y = 2, x = 4, y = 10 and x = 1, evaluate $\int_C \mathbf{F}.d\mathbf{r}$. **(15)**

(c) Evaluate $\iint_S \mathbf{F}.\mathbf{n}\, dS$, where $\mathbf{F} = x^2\mathbf{i} + y^2\mathbf{j} + z^2\mathbf{k}$ and S is that portion of the plane $x + y + z = 1$ which lies in the first octant. **(16)**

4. (a) State Green's theorem. Verify the theorem in the plane for $\oint_C [(xy + y^2)dx + x^2dy]$, where C is the closed curve of the region bounded by y = x, y = x^2. **($22\frac{2}{3}$)**

(b) State Gauss divergence theorem. Verify the theorem for $\mathbf{F} = 4x\mathbf{i} - 2y^2\mathbf{j} + z^2\mathbf{k}$ taken over the region bounded by $x^2 + y^2 = 4$, $z = 0$ and $z = 1$. **(24)**

SECTION – B

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

5. (a) By the method of Fröbenius, obtain two linearly independent solutions valid about x = 0 for the following differential equation: **($36\frac{2}{3}$)**

$$(x - x^2)y'' + (1 - x)y' - y = 0$$

(b) Prove that $J_{-\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}}\cos x$. **(10)**

6. (a) Show that $\int_0^x x^{-n} J_{n+1}(x)dx = \frac{1}{2^n \lfloor n} - x^{-n}J_n(x)$. **(15)**

(b) Prove that (Rodrigue's formula): **($20\frac{2}{3}$)**

$$P_n(x) = \frac{1}{2^n \lfloor n}\frac{d^n}{dx^n}(x^2 - 1)^n$$

(c) Express $f(x) = 4x^3 + 6x^2 + 7x + 2$ in terms of Legendre polynomial. **(11)**

7. (a) State and prove Heaviside's expansion formula and using this formula find **($20\frac{2}{3}$)**

$$L^{-1}\left\{\frac{3s + 1}{(s - 1)(s^2 + 1)}\right\}.$$

Contd P/3

MATH 261/ME

Contd... Q. No. 7

(b) Evaluate (using Laplace Transform): $\int_0^\infty \frac{e^{-xt}}{(1+x)\sqrt{x}}\,dx$. **(15)**

(c) Using convolution theorem, find $L^{-1}\left\{\frac{s}{\left(s^2+a^2\right)^{3/2}}\right\}$. **(11)**

8. (a) Using Laplace Transformation, solve: **(22)**

(i) $y'' - ty' + y = 1, \quad y(0) = 1,\ y'(0) = 2$.

(ii) $y''' - 3y'' + 3y' - y = t^2 e^t, \quad y(0) = 1,\ y'(0) = 0,\ y''(0) = 2$.

(b) Solve the boundary value problem (using Laplace Transformation): **(24⅔)**

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$$

with $u(x,0) = 3\sin 2\pi x$ and $u(0,t) = 0,\ u(1,t) = 0$ where $0 < x < 1,\ t > 0$.

L-2/T-1/ME **Date: 09/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2016-2017

Sub: **HUM 303** (Principle of Accounting)

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 is the difference between expense and loss? Explain with examples. **(5)**

(b) Rackbage Enterprise has the following transactions occured during the first month of operation January, 2016: **(30)**

January 01:	Invested Tk. 800000 in the business
January 03:	Borrowed Tk. 80000 from bank issuing a note.
January 07:	Purchased office equipment on account Tk. 20000.
January 12:	Earned revenue of Tk. 20000 cash for service provided.
January 14:	Paid salaries Tk. 3000 cash to the employee.
January 22:	Purchased supplies Tk. 500 for cash.
January 25:	Incurred utility expense for the month on account Tk. 2000.
January 28:	Withdrew Tk. 1000 cash from the business for personal use.
January 30:	Paid rent for office related to January month Tk. 20000.

Required:

(i) Journalize each transaction.

(ii) Prepare the ledger of 'Cash Account', 'Capital Account', 'Revenue Account' and 'Drawing Account'.

2. (a) What types of comparisons can be made with ratio analysis? **(5)**

(b) Canton Creez Comapny **(30)**

Trial Balance

June 30, 2016

Account title	Debit (Tk.)	Credit (Tk.)
Cash	6500	
Accounts Receivable	4000	
Prepaid Insurance	2400	
Supplies	1500	
Office Furniture	15000	
Account Payable		3500
Unearned Service Revenue		6000
Capital		20000
Service Revenue		3900
Salaries expense	2000	
Rent expense	1000	
Drawings	1000	
Total	33400	33400

Contd P/2

HUM 303/ME

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

Analysis reveals the following additional data:

- Accrued salaries Tk. 500
- Rent expense incurred but not paid on June 30 Tk. 600
- Services performed but not recorded Tk. 1500.
- Unearned service revenue of Tk. 1000 has been earned.
- Insurance expense expires @200 per month.
- Tk. 500 of supplies has been used during the month.
- Office equipment is being depreciated at Tk. 250 per month.

Required:

(i) Prepare necessary adjusting entries of June 30, 2016.

(ii) Prepare an adjusted trial balance at June 30, 2016.

3. (a) What are the limitations of a trial balance? **(5)**

(b) Prepare a tabular analysis from the transactions below of Mr. Erington's consultancy firm. **(18)**

(i) Invested Tk. 50000 in the firm.

(ii) Provide consultancy service for Tk. 5000.

(iii) Paid interest expense Tk. 1000 cash.

(iv) Purchase office furniture on account Tk. 10000.

(v) Provide service on account Tk. 2000.

(vi) Paid dues on furniture purchase.

(vii) Received cash for services provided on account.

(viii) Owner's draw Tk. 1000 cash.

(ix) Paid rent expense Tk. 10000.

(c) **(12)**

Symphone Corporation

Balance Sheet

As on December 31

	2015	2016
Cash	Tk. 4300	Tk. 3700
Account Receivable	21000	23400
Inventory	10000	7000
Land	20000	26000
Building	70000	70000
Accumulated depreciation	(15000)	(10000)
Total Assets	110500	120100
Account Payable	12370	31100
Stockholder's Equity	98130	89000
Liability Equity Total	110500	120100

Contd P/3

HUM 303/ME

Contd... Q. No. 3(c)

Symhone's 2016 Income statement included net sales of Tk. 100000, cost goods sold Tk. 60000 and net income Tk. 15000.

Required:

(i) Current ratio
(ii) Quick ratio
(ii) Receivable turnover
(iv) Inventory turnover
(v) Profit margin
(vi) Return on stockholder's equity.

4. Gamberry Perfume Company **(35)**

Trial Balance

As on 31st December, 2016

Account title	Debit (Tk.)	Credit (Tk.)
Cash	20500	
Accounts Receivable	15000	
Account Payable		12000
Mortgage Payable		3700
Inventory (01-01-2016)	5800	
Purchase	20100	
Sales		40500
Sales Return	1200	
Purchase discount		500
Capital		36200
Drawings	2300	
Salaries	3400	
Prepaid Insurance	3600	
Machinery	16000	
Rent expense	5000	
Copyright	20000	
Bond Payable (long term)		20000
Total	112900	112900

Other Information:

- Inventory (31-12-2016) Tk. 6700
- Rent is 40% administrative and 60% selling.
- Salary of the sales person is payable Tk. 600.

Required:

(i) Prepare a multiple step Income Statement.
(ii) Prepare a statement of owner's equity and
(iii) A classified balance sheet as on December 31st, 2016.

Contd P/4

HUM 303/ME

SECTION-B

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

5. (a) What is management accounting? Distinguish between financial accounting and management accounting. **(5)**

(b) Show in a diagram the classification of costs into different categories. **(5)**

(c) Total costs of producing 300 units and 450 units of a product of Dhaka Company Ltd are Tk. 10,000 and Tk. 13,750 respectively. **(5)**

Required:

Calculate variable cost per unit, total fixed cost, and total cost of producing 600 units.

(d) Following are the particulars taken from the books of Keraniganj Manufacturing Company for the year ended 31 December 2016: **(20)**

Inventories	1 January		31 December
Raw Materials	Tk. 30,000		Tk. 35,000
Work-In-Process	40,000		50,000
Finished Goods	55,000		45,000
Raw Materials Purchased (net)		Tk. 200,000	
Purchase Returns		20,000	
Sales Revenue		500,000	
Sales Returns		35,000	
Freight Out		40,000	
Labor (80% direct)		150,000	
Depreciation (70% factory)		50,000	
Sales Commission		60,000	
Factory Rent		40,000	
Office Rent		30,000	
Factory Insurance		30,000	
Marketing Expenses		40,000	
Factory Utilities		20,000	
Factory Supplies		15,000	
Supervisor's Salary		25,000	
Other Factory Expenses		15,000	
Office Supplies		10,000	
Miscellaneous Office Expenses		5,000	

Required:

Prepare a Cost of Goods Manufactured Statement and an Income Statement for the year ended 31 December 2016.

Contd P/5

6. (a) Explain the concept of break-even point with a graph (using graph paper is not necessary). **(5)**

(b) The selling price per unit, variable cost per unit, and total fixed costs for the year of Barilgaon Company Limited are Tk. 80, Tk. 56, and Tk. 192,000 respectively. **(5)**

Required:

Calculate contribution margin ratio, variable expense ratio, and net income for 10,000 units sold.

(c) The selling price per unit, variable-expense ratio, and total fixed costs for the year of Taranagar Comany Limited are Tk. 120, 60%, and Tk. 384,000 respectively. **(5)**

Required:

How many units will have to be sold in order to earn a target profit of Tk. 96,000?

(d) The following worksheet contains cost and revenue data for Kalatia Shoe Company: **(20)**

Particulars	Total 15,000 Pairs of Shoes	Per pair of Shoes
Sales revenue	Tk. 22,5000,000	Tk. 1,500
Variable expenses:		
Invoice cost	10,125,000	Tk. 675
Sales commission	3,375,000	225
Total variable expenses	Tk. 13,500,000	Tk. 900
Contribution Margin	**Tk. 9,000,000**	**Tk. 600**
Fixed expenses:		
Advertising	Tk. 1,500,000	
Rent	1,000,000	
Salaries	5,000,000	
Total fixed expenses	Tk. 7,500,000	
Net Operating Income	**Tk. 1,500,000**	

Required:

(i) Calculate the annual break-even point in units and in sales value.

(ii) Calculate the margin of safety in sales value and in percentage form.

(iii) Calculate the degree of operating leverage, and calculate the increase in net income if sales revenue is expected to increase by 10% next year.

(iv) Which of the following independent situations would you recommended in order for the company to increase the sales volume by 3,000 pairs of shoes?

- Reducing the selling price by Tk. 50 per pair of shoes;
- Paying the store manager Tk. 20 commission on each pair of shoes sold in addition to salesperson's commission;
- Eliminating sales commissions entirely in its shops and increasing fixed salaries by Tk. 1,740,000 annually.

Contd P/6

7. (a) Distinguish between absorption costing and variable costing. **(5)**

(b) Show the comparative income effects on inventory under absorption and variable costing. **(5)**

(c) The variable costing unit cost of a product of Xinxira Comapny is Tk. 20. The fixed manufacturing overhead and fixed selling and administrative expenses are Tk. 120,000 and Tk. 70,000 respectively. During its first year of operations, Xinxira produced 10,000 units and sold 8,000 units. During its second year of operations, it produced 6,000 units and sold 8,000 units. **(5)**

Required:

Compute the absorption costing unit product cost for Year 1 and Year 2.

(d) THT Company manufactures and sells one product. The following information pertains to each of the company's first two years of operations: **(20)**

Variable costs per units:	
Manufacturing:	
Direct materials	Tk. 15
Direct labor	Tk. 10
Variable manufacturing overhead	Tk. 5
Variable selling and administrative expense	Tk. 2
Fixed costs per year:	
Fixed manufacturing overhead	Tk. 100,000
Fixed selling and administrative expenses	Tk. 50,000

During its first year of operations, THT produced 25,000 units and sold 20,000 units. During its second year of operations, it produced 20,000 units and sold 25,000 units. The selling price of the company's product is Tk. 40 per unit.

Required:

(i) Calculate the unit product cost for Year 1 and 2 under variable and absorption costing.

(ii) Prepare an income statement for Year 1 and 2 under variable and absorption costing.

8. (a) What is Capital Budgeting Decision? Describe the importance of Capital Budgeting Decision. **(6)**

(b) Write down the types of Capital Budgeting Decision with examples. **(9)**

Contd P/7

HUM 303/ME

Contd... Q. No. 8

(c) A company wants to purchase a new equipment. The related information of the equipment is as follows: **(20)**

Cost of the equipment Tk. 70,000	
Year	Net Profit After Tax (NPAT)
1	Tk. 40,000
2	13,000
3	20,000
4	10,000
5	7,000

Required:

Determine:

(i) Pay Back Period (PBP)

(ii) Internal Rate of Return (IRR)

(iii) Net Present Value at 10% cost of capital.

Should the company buy the equipment?

L-2/T-1/ME **Date: 05/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2016-2017

Sub : **ME 247** (Engineering Mechanics - 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**.

Symbols indicate their usual meaning. Assume any missing data.

1. (a) Two forces P and Q are applied as shown in Fig. 1(a) to an aircraft connection. Knowing that the connection is in equilibrium and that P = 2225 N and Q = 2890 N, determine the magnitudes of the forces F_A and F_B exerted on the rods A and B. **(17)**

   (b) Three cables AB, AC, and AD are used to tether a balloon as shown in Fig. 1(b). Determine the vertical force P exerted by the balloon at A knowing that the tension in cable AD is 481 N. **(18)**

2. (a) In Fig. 2(a), the tension in cable AC is 1065 N. Determine the moment about each of the coordinate axes of the force exerted on the plate at C. **(17)**

   (b) Three forces and a couple act on crank ABC as shown in Fig. 2(b). For P = 25 N and α = 40°, (i) determine the resultant of the given system of forces, (ii) locate the point where the line of action of the resultant intersects a line drawn through point B and C. **(18)**

3. (a) The truss shown in Fig. 3(a) was designed to support the roof of a food market. For the given loading, determine the force in members KM, LM, and LN. Solve the problem by the method of section. **(17)**

   (b) The press shown in Fig. 3(b) is used to emboss a small seal at E. Knowing that P = 250 N, determine (i) the vertical component of the force exerted on the seal, (ii) the reaction at A. **(18)**

4. (a) Cable ACB supports a load uniformly distributed along the horizontal as shown in Fig. 4(a). The lowest point C is located 9 m to the right of A. Determine (i) the vertical distance a, (ii) the length of cable, (iii) the components of the reaction at A. **(17)**

   (b) Determine the couple M that must be applied to member $DEFG$ as shown in Fig. 4(b) to maintain the equilibrium of the linkage. Solve the problem by principle of virtual work. **(18)**

Contd P/2

SECTION – B

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

5. (a) Using Direct integration method, determine the location of the centroid for the hemispherical solid shown in Figure for Q. No. 5(a). **(12)**

   (b) If the line and the circular arc together are revolved 270° with respect to y-axis [shown in Figure for Q. No. 5(b)], then find the generated area using Pappus-Guldinus theorem. (All coordinates are given in mm.) **(12)**

   (c) Determine the center of gravity of the shaded area shown in Figure for Q. No. 5(c). Each small square represents 10 mm in both directions. **(11)**

6. (a) Determine the moment of inertia with respect to x-axis for the shaded area shown in Figure for Q. No. 6(a). All dimensions are in mm. Use direct integration method. **(12)**

   (b) Determine the mass moment of inertia for the rectangular solid [shown in Figure for Q. No. 6(b)] with respect to line AB. (All dimensions are in mm). Mass of the block is M. **(11)**

   (c) Determine the mass moment of inertia of the conical solid object shown in Figure for Q. No. 6(c) with respect to y axis. Use direct integration method. All dimensions are in mm. Assume the density of the material is ρ. **(12)**

7. (a) Block 'A' and block 'B' weight 50 kg and 25 kg respectively and they are attached with each other with a non-stretchable string as shown in Figure for Q. No. 7(a). Assuming the pulley is frictionless; determine the value of θ for which motion is impending (μ_s for all surfaces in contact is 0.15). **(12)**

   (b) Find the largest magnitude of couple M that can be applied on the cylinder without spinning [shown in Figure for Q. No. 7(b)]. The cylinder has a weight of 'W' and a radius of 'r'. Coefficient of static friction for all surfaces is 'μ_s'. **(11)**

   (c) A 100 kg block is supported by a rope that is wrapped 2.5 times around a horizontal rod as shown in Figure for Q. No. 7(c). Knowing that the coefficient of static friction between the rope and the rod is 0.15, determine the range of values of '*P*' for which equilibrium is maintained. **(12)**

8. (a) A vertical load **P** is applied at end *B* of rod *BC* as shown in Figure for Q. No. 8(a). Neglecting the weight of the rod, express the angle θ corresponding to the equilibrium position in terms of *P*, *l*, and the counterweight *W*. **(18)**

   (b) For the plate shown in Figure for Q. No. 8(b), determine the reactions at *A* and *B*. Neglect the weight of the plate. **(17)**

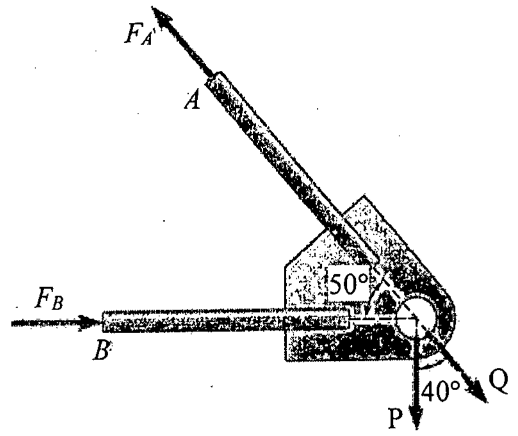


Fig. 1(a)

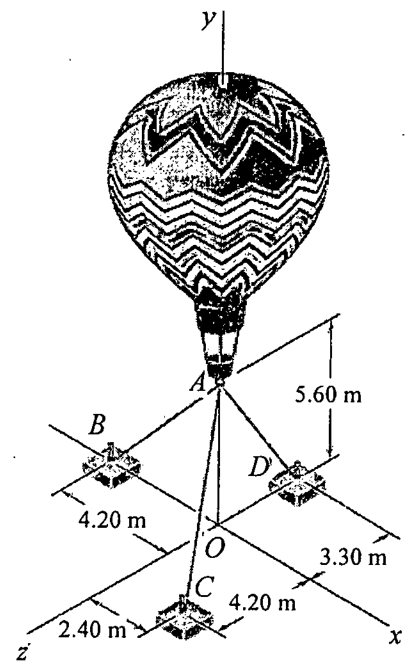


Fig. 1(b)

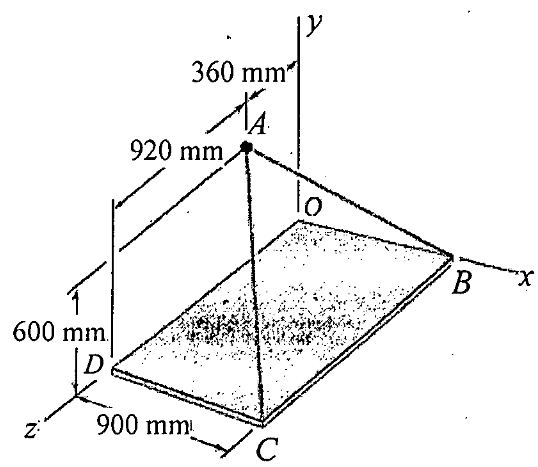


Fig. 2(a)

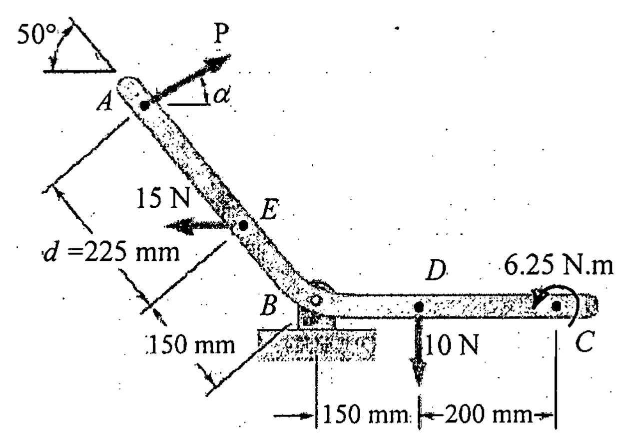


Fig. 2(b)

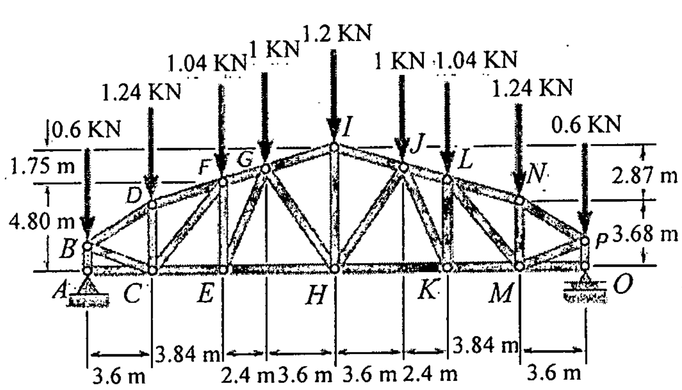


Fig. 3(a)

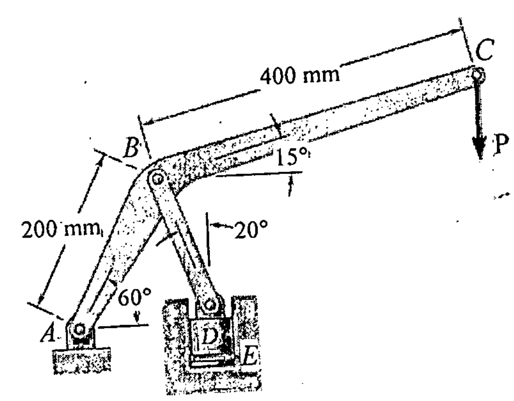


Fig. 3(b)

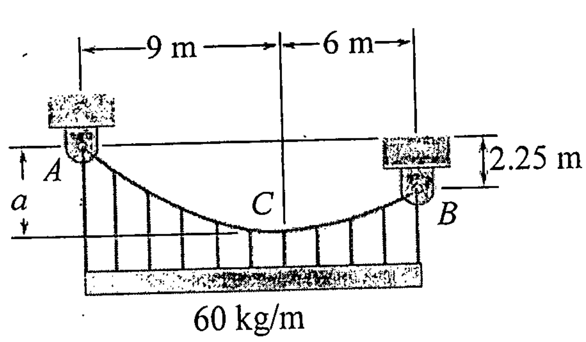


Fig. 4(a)

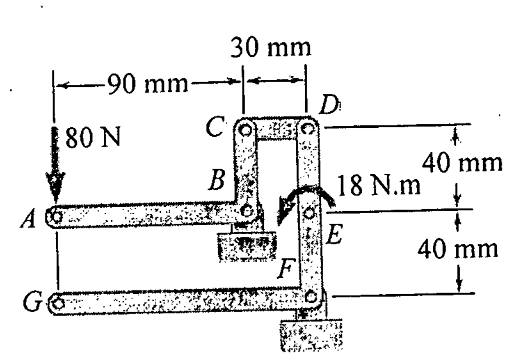


Fig. 4(b)

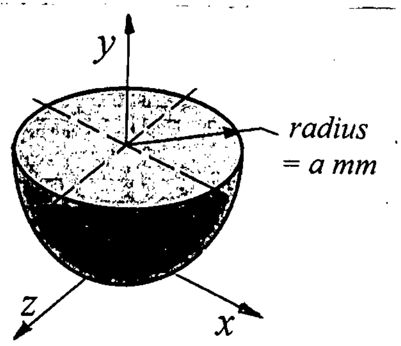


Figure for question No: 5(a)

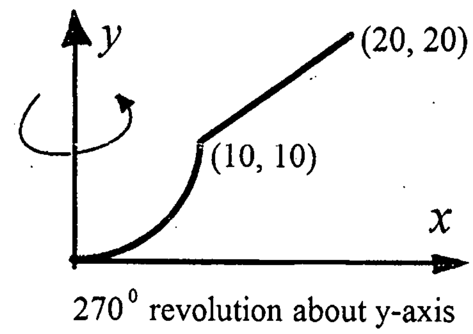


Figure for question No: 5(b)

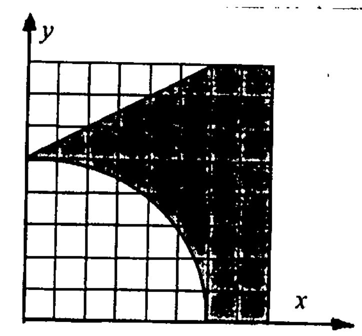


Figure for question No: 5(c)

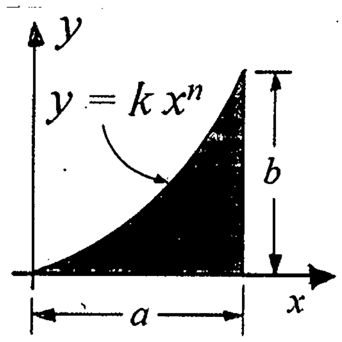


Figure for question No: 6(a)

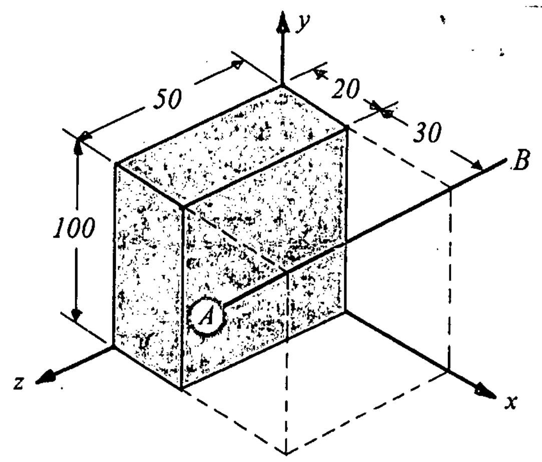


Figure for question No: 6(b)

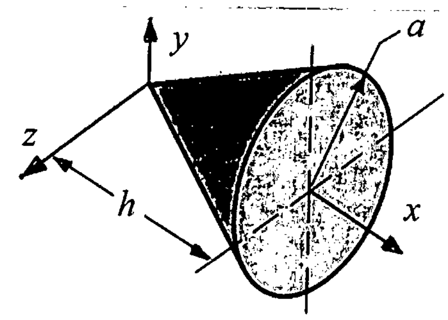


Figure for question No: 6(c)

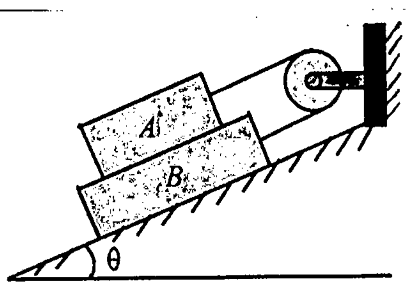


Figure for question No: 7(a)

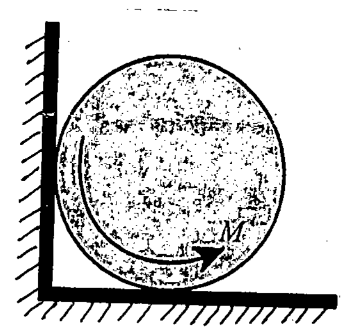


Figure for question No: 7(b)

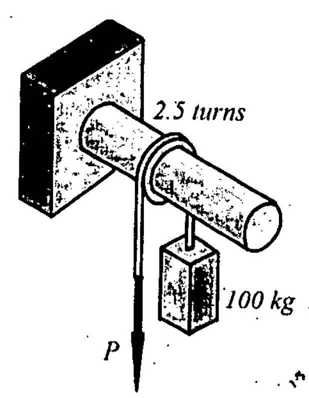


Figure for question No: 7(c)

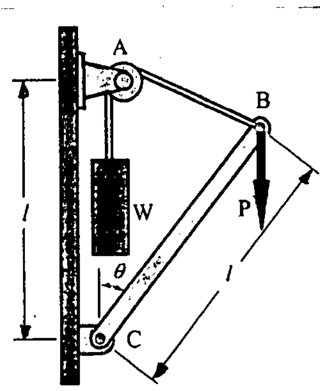


Figure for question No: 8(a)

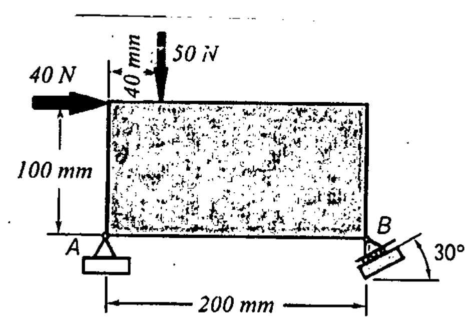


Figure for question No: 8(b)