L-1/T-1/CSE **Date : 31/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **CSE 101** (Structured Programming Language)

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**.

Please read carefully, some questions might have additional restrictions such as not allowing the use of any library function except the I/O related ones.

1. (a) What is the output of the following piece of code? Assume that the variables i and n have been declared as integers. **(5)**

```
for(n =1; n <= 5; n++)
    for(i  = 1; i < n; i++)
      printf("%d%c", i, (i == n-1)? '\n': ',');
```

(b) In mathematics, a **semiprime** is a natural number that is the product of two prime numbers. The semiprimes less than 100 are: **(10)**

4, 6, 9, 10, 14, 15, 21, 22, 25, 26, 33, 34, 35, 38, 39, 46, 49, 51, 55, 57, 58, 62, 65, 69, 74, 77, 82, 85, 86, 87, 91, 93, 94, and 95

Write down a program that will take an integer N as input and will determine whether N is semiprime or not. **You are allowed to use any array any memory dynamically to solve this problem.**

(c) Any number in the Fibonacci series is the summation of two previous numbers in the series. The first two numbers are predefined as 1, 1. The series can be shown as follows: **(10)**

1, 1, 2, 3, 5, 8, 13, ...

Write down a program that will take a number N (> 0) as input and will perform the following two tasks:

(i) Check whether N belongs to the Fibonacci series or not. Print YES or NO accordingly.

(ii) Find and print summation of all numbers in the series that are less than or equal to N.

(d) Write down a program that will clone itself in reverse, i.e., copy its own content in reverse order. Name the copy as rcopy.c. **(10)**

2. (a) Suppose we have a list of student names, identification numbers, and grades. For example, the beginning of the list might look like: **(20)**

Casanova	910017	B
Ayaan	934422	A
Smith	978766	C

Contd P/2

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Contd... Q. No. 2(a)

Suppose there are five possible grades A, B, C, D, and F.

(i) Write down a program called recorder that will perform the following tasks: Take the above data as input and put it into an array of structure. The number of students N will also be input to your program first. Define your own structure. Assume that the names are single word names with max length of 50. The program should print out an ordered list of students and grades, i.e. students with A grades should be listed first, students with B grade next and so forth. Among all students having the same grade, the students should be listed alphabetically by name.

(ii) Add a function class_average to your program that will compute the class average and print it. Assume that A grade has value 4.0, a B grade has value 3.0, and so forth.

(b) What gets printed by the following program? **(10)**

```
struct test {
    unsigned a:1, b: 2, c: 3;
};

int main( ){
    int i;
    struct test x;

    for(i = 0; i < 8; ++i){
            x.a = x.b = x.c = i;
            printf("%d   %d   %d\n", x.a, x.b, x.c);
    }
}
```

What happens if you replace the statement

```
x.a = x.b = x.c = i;     by        x.c = x.b = x.a = i;
```

(c) Between the following two structures which one consumes less memory? Show the calculation. **(5)**

```
struct A{                    struct B{
    char a;                      char a;
    float d;                     char c;
    char c;                      float d;
};                           };
```

3. (a) Write down the code snippet and fill out an N × N matrix A[N][N] to create the following pattern. Assume that N will be input to your program. **(10)**

1	1	1	1	1	0
1	1	1	1	0	-1
1	1	1	0	-1	-1
1	1	0	-1	-1	-1
1	0	-1	-1	-1	-1
0	-1	-1	-1	-1	-1

Contd P/3

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(b) A degree n-polynomial is of the form: **(12)**

$$p(x) = a_0 + a_1x + a_2x^2 + ... + a_ix^i + ... + a_nx^n$$

Here coefficients $a_0, a_1, a_2, ..., a_n$ are real numbers. If n ! = 0 then the degree of the p(x) is n. Polynomials can be defined in a machine by an array such as where you just need to store the coefficients. Write down the following two functions:

(i) `double eval (double a [ ], double x, int n);`

that returns the value of polynomial p evaluated at x. Note that n is the max degree.

(ii) `void add(double f [ ], double g [ ], double h [ ], int n);`

that adds two polynomials g and h of at most degree n and store the result in f.

(c) Write a function int ALTERSUM (int N, int M, int B [ ][M] to find and return the sum of every alternate element of a two-dimensional array B starting from B[0][0]. There are N rows and M columns in B. **(13)**

4. (a) Suppose we have defined a macro SQ like below: **(5)**

```
#define SQ(x) ((x) * (x))
```

Find a scenario where the above macro will lead to a compilation error.

(b) Consider the following two macros: **(5)**

```
#define SQ(x) ((x) * (x))
#define CUBE(x) (SQ(x) * (x))
```

Define a third macro F_POW(x) using the above two macros in your definition that will produce:

$$x^{\frac{3}{4}}$$

(c) Write down the following functions. You are not allowed to use logical operators, arithmetic operators, relational operators, if-else, switch-case, loop, or any library function. You can only use bitwise operators to solve these problems. **(3×5=15)**

(i) `int copyABit(int x, int n)` copies nth bit of y to all bit positions of x, where $0 \le n \le 31$.

CopyABit(5,7, 2) returns -1 (i.e., the bit of y at position 2 is 1)

CopyABit(5,7, 9) returns 0 (i.e., the bit of y at position 9 is 0)

(iii) int isPositive(int x) returns -1 if x is positive and 0 otherwise

(iii) int negate(int x) returns-x.

(d) Write down a function that will reverse the bit representation of an int. Here is an example of a reversing operation: **(10)**

An integer: 10101110 11011010 01101111 11011011

Its reverse: 11011011 11110110 01011011 01110101

Contd P/4

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SECTION - B

There are **FOUR** questions in this section. Answer any **THREE**.
Read the constraints/notes mentioned in each question carefully. You *must* adhere to the constraints in answering the respective question. Violation of constraint(s) will result in deduction of full marks.

5. (a) Write a program that can detect whether a point is inside or outside a rectangle. The rectangle's sides are parallel to the axes of the XY plane. Your input are x, y coordinates of 3 points (assume integer coordinates). The first 2 points respectively represent the top left and bottom right corners of the rectangle. The 3rd input point is the query point. Print "Inside the rectangle" if the query point is inside or on the boundary of the rectangle. Otherwise print "Outside the rectangle". **(10)**

(b) You are given the unit price of some commodities as follows. For first 100 units, the rate is 1.0 Taka/ unit. For the next 150 units, it is 1.25 taka/ unit. Then onward, the price is 1.5 taka/unit. Write a program that takes an integer *n* as input. *N* represents the number of units bought by the customer. The program should output a floating point number, up to 2 decimal digits, representing the total price. **(10)**

(c) Write a program that takes a character as input and prints out one of the following sentences as appropriate: **(10)**

- Vowel in capital letter
- Vowel in small letter
- Consonant in capital letter
- Consonant in small letter
- Neither a vowel nor a consonant

(d) What will be the output of the following program, if the input to the program is 0? **(5)**

```
#include <stdio.h>

int main() {
    int i;
    scanf("%d", &i);
    if (++i) {
        int i = 50;
        printf("%d\n", i++);
    }
    printf("%d\n", i);
    return 0;
}
```

6. (a) Write a recursive function to find and return the largest element in an array of integers. Do not use loops, static or global variables. The prototype of the function must be: **(15)**

```
int largest (int x [], int n)
```

Here *x* is the array of integers, while *n* represents the number of integers in the array. After implementing the function, write a simple main function to demonstrate how you would make the initial call to the recursive function.

Contd P/5

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Contd... Q. No. 6

(b) Write a recursive function that takes an unsigned integer as parameter and prints to console its binary representation. Do not use loops, static or global variables. If the integer parameter is 0, then a 0 should be printed. In all other cases, no leading zeros should be printed. The prototype of the function must be: **(15)**

```
void printBinary(unsigned int x);
```

The calling pattern from the main function should be as follows: If the integer 25 is to be printed in binary, then `printBinary(25)` should be called. In other words, no pre-processing should be done in `main ()`. There is no need to write `main ()`.

(c) Write a function to calculate and return the length of a string. The string is passed to the function as a parameter. Do not use string. h header file. **(5)**

7. (a) How is static local variable declared? Explain with an example how static local variable differs from a regular local variable. **(10)**

(b) Write a program to take as input height of several students in centimeters. Read from console the number of students (integer), then as many real values. You must allocate memory dynamically. After storing the heights, find and print the height difference between the tallest and the shortest student. Then free the allocated memory. **(10)**

(c) Using a pointer to pointer and appropriate dynamic memory allocation, write a program to store a matrix of integers and then print the average of the integers in each column of the matrix. The input starts with 2 integers representing the number of rows (r) and columns (c) respectively. Then the numbers in the matrix are given in a row major order (i.e. the first c integers represent the first row, the next c integers represent the second row and so on). Before the program exits, you must appropriately free the dynamically allocated memory. **(15)**

8. (a) Write a program to perform lexicographical comparison between two strings. **(10)**

(b) Write a program that takes a string (does not contain any space characters) followed by a character as input. The 1st input (string) and the 2nd input (character) are separated by a single space. The string will be no larger than 25 characters. You must store this string in a character array called *str*. From *str*, delete all occurrences of the character in the 2nd input. For example, if *str* is "abcbabxy" and *c* is 'b', then the resulting string will be "acaxy". Do not use string. h header file in this task. Also, do not declare any arrays other than *str*. **(10)**

(c) Write a program that takes 2 strings (may contain space characters) as input. Then it prints their longest common substring. A substring of a string is a part of that string. For example for the string "abcd", the possible substrings are: "a", "ab", "abc", "abcd", "b", "bc", "bcd", "c", "cd" and "d". For the 2 strings "abcdef" and "ccddefg", the longest common substring is "def". If there are multiple longest common substrings, you can print any one of them. **(15)**

L-1/T-1/CSE **Date : 11/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **EEE 163** (Introduction to Electrical 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) Find the resistance shown across terminal c-d (Rcd) for the circuit in Fig. Q. 1(a) **(18)**

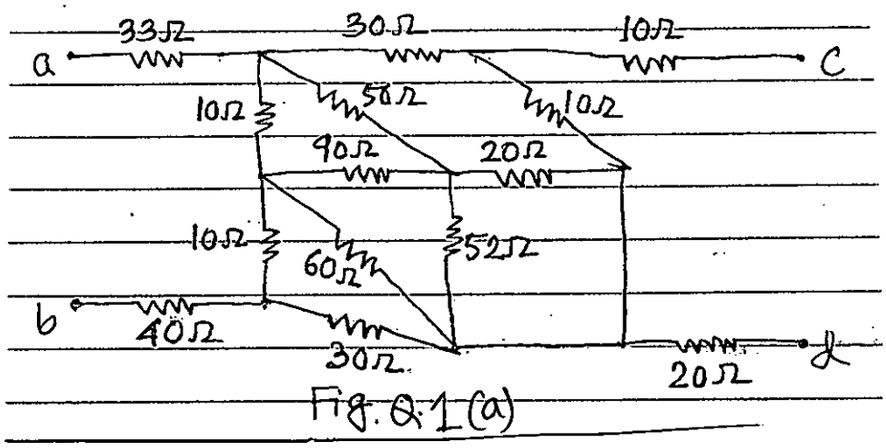

Fig. Q. 1(a)

(b) Determine the values of node voltages V_1, V_2, V_3, V_4 and the power of the dependent source for the circuit in Fig. Q. 1(b) **(17)**

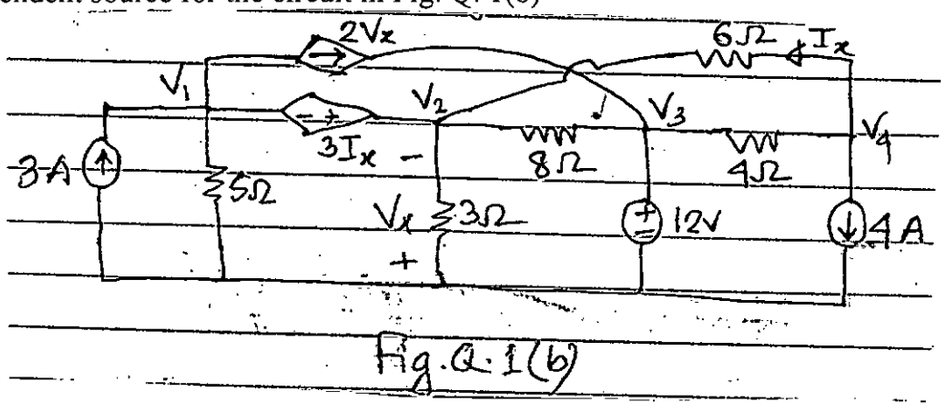

Fig. Q. 1(b)

2. (a) Find the Norton equivalent circuit across terminal a – b of the circuit in Fig. Q. 2(a) **(20)**

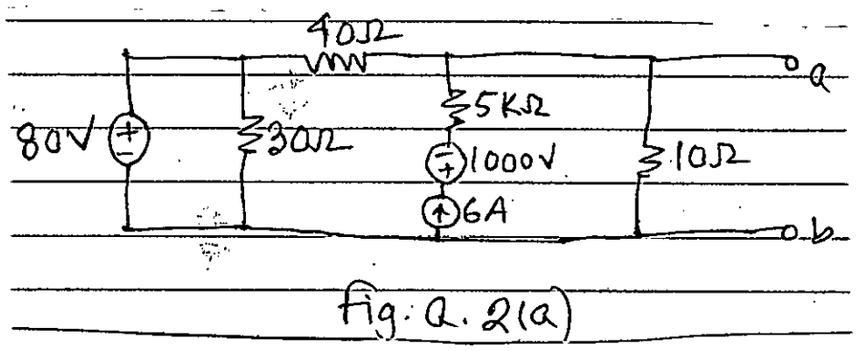

Fig. Q. 2(a)

(b) Two networks A and B composed only of resistors and sources are connected as shown below **(8)**

Contd P/2

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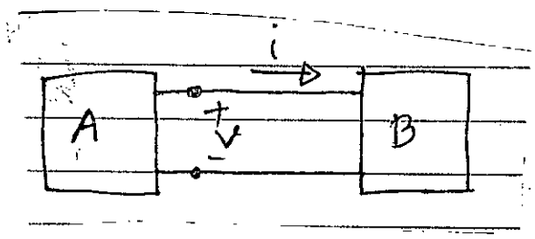
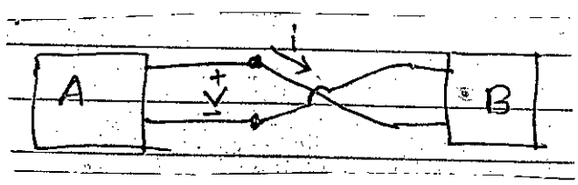
Contd … Q. No. 2(b)



The voltage and current are measured to be V = 1V, i = 0 mA. When the connection is reversed as shown below:



New values of voltage and current are V = 0.5 V, i = 0.5 mA. Determine the Thevnin equivalent circuit of A and B

(c) Find the current delivered by the 10 V source. **(7)**

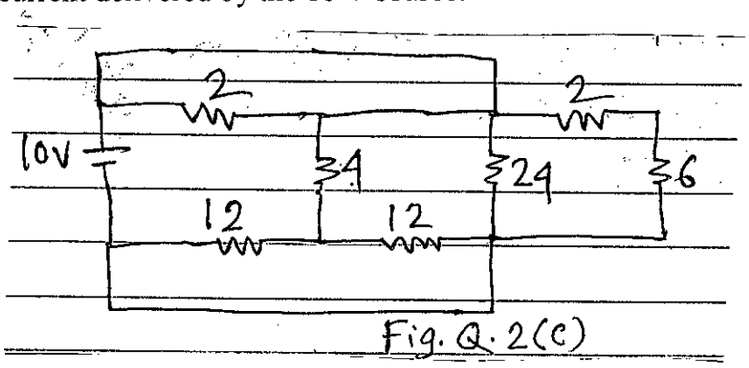


Fig. Q. 2(c)

3. (a) In solving for currents using mesh analysis, the following equations are obtained. Draw the circuit and find the currents. **(12)**

$15\, i_1 - 10\, i_2 = -10$

$10\, i_1 - 22\, i_2 + 10\, i_3 = 0$

$10\, i_2 - 15\, i_3 = 12$

(b) Find the value of R in Fig. Q. 3(b). **(18)**

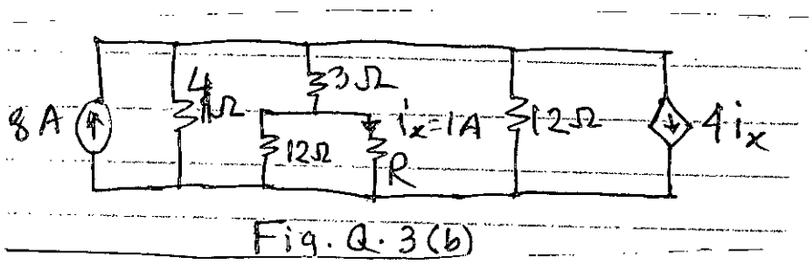


Fig. Q. 3(b)

(c) Find the power delivered to R_1 resistor in Fig. Q. 3(c) **(5)**

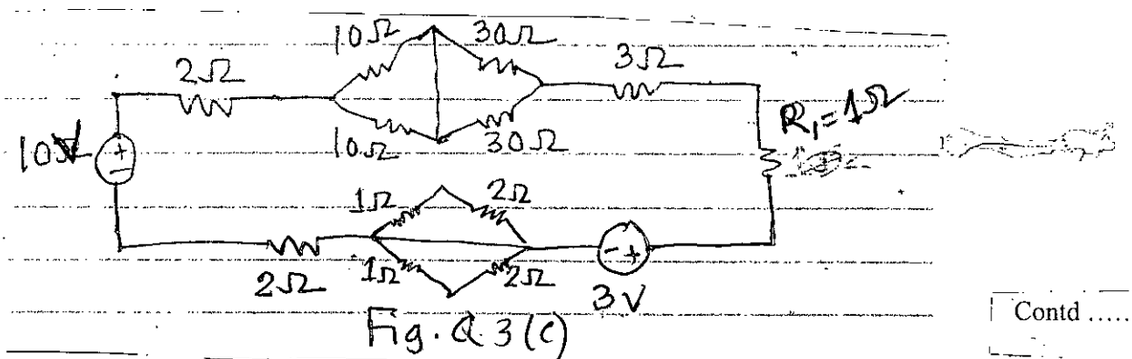


Fig. Q 3(c)

Contd P/3

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4. (a) Using source transformation, Find value of V_1 in the circuit of Fig. Q. 4(a) **(20)**

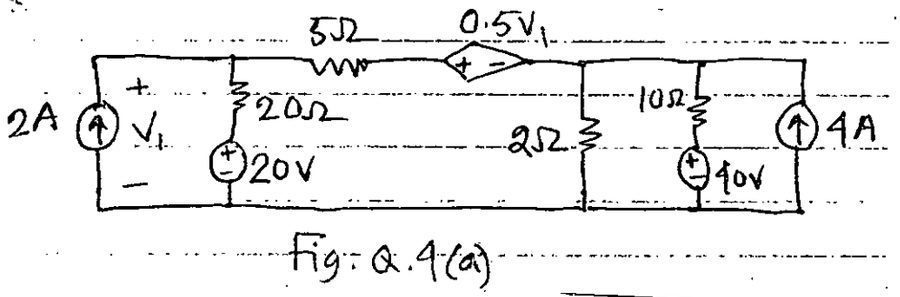

Fig: Q.4(a)

(b) Using only TWO OP AMPS, generate the output V_o from V_1, V_2, V_3 as input voltages. **(15)**

$$V_o = 10V_1 + 5\int V_2 dt - 20\frac{dV_3}{dt}$$

SECTION – B

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

5. (a) For the network shown in Fig. 5(a), calculate the equivalent impedance connected to the source and total real power delivered by the source for frequency f = 1 kHz and f = 10 kHz. **(20)**

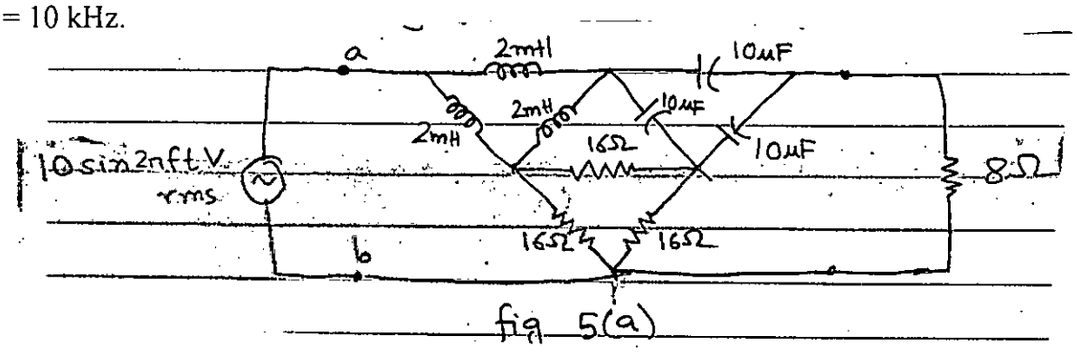

fig 5(a)

(b) Find the power dissipated by the 8 Ω resistor in Fig. 5(a) for f = 1 kHz frequency. **(10)**

(c) The voltage v = 12 cos (60 t + 45°) V is applied across a 0.1 H inductor. Sketch a phasor diagram showing the voltage across the inductor and current through the inductor. **(5)**

6. (a) For the circuit shown in Figure 6(a), find the angular frequency, ω and load capacitance, C_L, for which, the average power absorbed by R_L is maximized. Find the maximum average power, the instantaneous power, and complex power at ω angular frequency. **(20)**

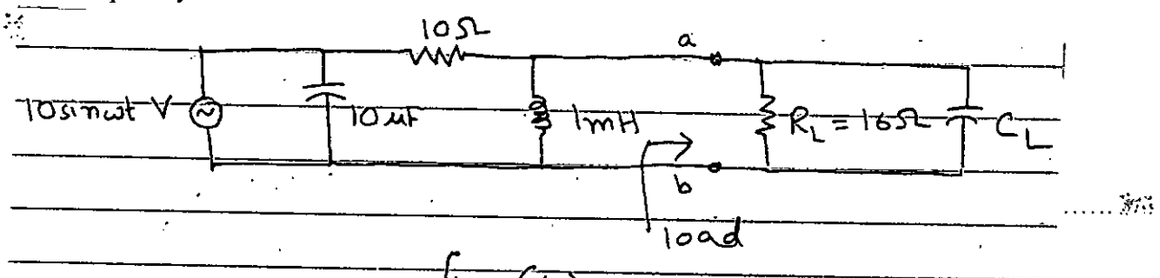

fig. 6(a)

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(b) For a 220 V – rms 50 Hz power line, a load absorbs 4 kW power at lagging power factor of 0.8. Find the value of capacitance necessary to raise the power factor to 0.95. **(10)**

(c) Find the wattmeter reading of the circuit in fig. 6(c) **(5)**

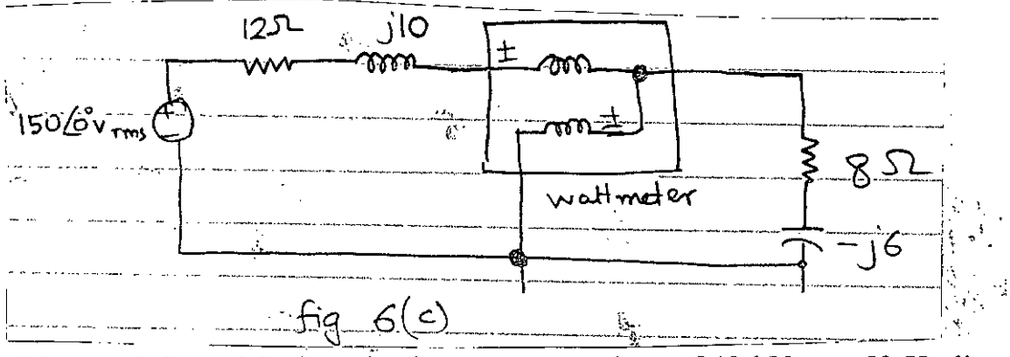

fig 6(c)

7. (a) Two balanced 3-phase loads are connected to a 240 kV rms 50 Hz line. Load 1 draws 30 kW at lagging power factor of 0.6, while load 2 draws 45 kVAR at lagging power factor of 0.8. Determine the line currents for each of the 3 lines and the real, reactive and complex power absorbed by the combined load. **(15)**

(b) For the unbalanced circuit in fig. 7(b) calculate the line currents and total complex power absorbed by load **(15)**

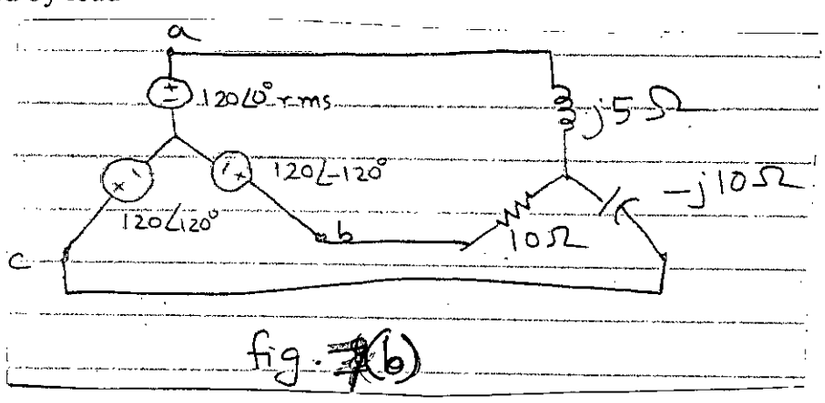

fig. 7(b)

(c) Derive the relationship between the impedances of a balanced Δ and a balanced Y equivalent network. **(5)**

8. (a) For the circuit shown in fig. 8(a), determine what kind of filter it is. Calculate the 3dB corner/cut-off frequency if R = 1 kΩ, L = 2 H and C = 2 μF. **(20)**

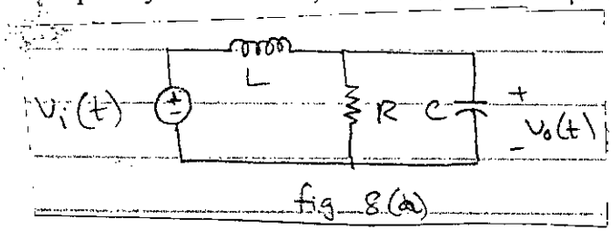

fig 8(a)

(b) Determine the equivalent impedance of the circuit between terminals a and b of figure 8(b) **(15)**

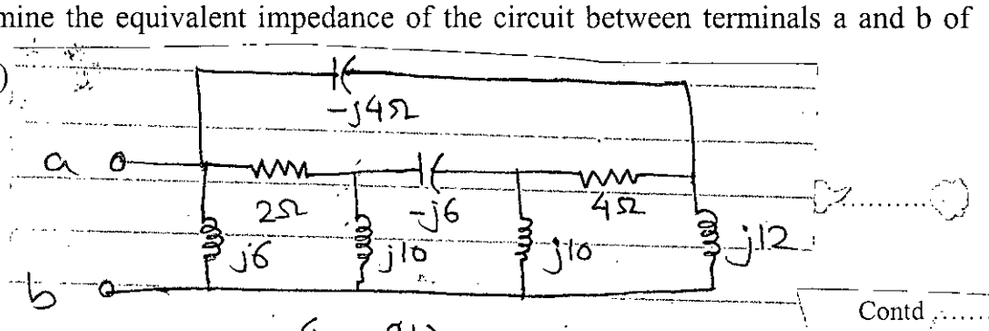

fig 8(b)

Contd P/5

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Contd...Q. No. 8

(c) For a set of 3-phase voltages, **(5)**

$$V_{an} = 200 \cos (\omega t + 20°)$$

$$V_{bn} = 200 \cos (\omega t - 220°)$$

$$V_{cn} = 200 \cos (\omega t - 110°)$$

Determine the phase sequence.

L-1/T-1/CSE **Date : 04/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **PHY 109** (Heat and Thermodynamics, Electricity and Magnetism, Waves and Oscillation and Mechanic)

Full Marks: 280 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) What do you mean by 'degree of freedom' of a dynamical system'? State the principle of equipartition of energy. **(12)**

   (b) Prove that for a monoatomic gas the value of γ, the ratio of the two specific heats is 5/3, for a diatomic gas is 7/5 and for a triatomic gas is 4/3. **(26⅔)**

   (c) Calculate the temperature at which the average translational kinetic energy of the molecules of a gas is one-third of the average translational kinetic energy of its molecules at 180°C. **(8)**

2. (a) Define the term 'entropy of a substance' and the 'heat death' of the universe. **(10)**

   (b) Draw the temperature entropy (T, S) diagram and prove that its area represents available energy. **(15)**

   (c) Define and explain four fundamental thermodynamic potentials U, F, H and G, where the symbols have their meaning. **(16)**

   (d) Using thermodynamic potentials, derive the following Maxwell thermodynamic relation **(5⅔)**

$$\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$$

3. (a) What is damped harmonic motion? **(4)**

   (b) Derive the different equation of a damped harmonic motion and solve this equation. Discuss in details the conditions of under-damped, over-damped and critically damped motion. **(32⅔)**

   (c) In one dimensional motion of a mass of 10 gm, acted upon by a restoring force of 10 dyne/cm and a resistive force of 2 dyne-sec/cm. **(10)**

   (i) Find whether the motion is oscillatory or not.

   (ii) Find the value of the damping constant which will make the motion critically damped.

   (iii) Find the value of the mass for which the motion will be critically damped.

Contd P/2

PHY 109

4. (a) What is wave? Distinguish between progressive and standing waves. **(10)**

(b) Discuss analytically the formation of stationary waves in a linear bounded medium. Show that, in case of stationary wave. No energy is transferred across any section of the medium. **(26⅔)**

(c) Two transverse sine waves, each of amplitude 3 mm, wavelength 2m, time period 2 sec are travelling along the x-axis in opposite directions. They are in phase at x = 0, t = 0. Obtain the equation of the resultant wave and comment on its nature. Calculate the maximum displacement at x = 2.3 m. **(10)**

SECTION - B

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

5. (a) What is electric potential? Find an expression for electric potential due to a dipole. **(12)**

(b) A solid nonconducting sphere of radius, R, has a total charge, Q. Find the electric potential both inside and outside the sphere. Draw schematically electric potential as a function of distance from the center of the sphere. **(22⅔)**

(c) Consider ^{238}U nucleus ($Z=92$) on the verge of fission. Calculate (i) the repulsive force acting on each fragment, and (ii) the mutual electric potential of the two fragments. Assume that the fragments are equal in size and charge, spherical and just touching. The radius of ^{238}U nucleus is $8 \times 10^{-15}m$. Assume that the material out of which nuclei are made has constant density. **(12)**

6. (a) State and explain Biot-Savart law and Ampere's law. What are the advantages of Ampere's law over Biot-Savart law? **(12)**

(b) A cylindrical conducting wire of radius, R, carries current, I, distributed uniformly across the cross-section. Using Ampere's law calculate the magnetic induction, $\boldsymbol{B}$, at a distance, r, from the center of the wire for following cases: **(22⅔)**

(i) outside ($r>R$), (ii) inside ($r<R$) and, (iii) surface ($r=R$) of the wire. Draw schematically $B(r)$ as function of r.

Contd P/3

PHY 109

Contd... Q. No. 6

(c) A long coaxial cable consists of two concentric conductors, inner solid conductor having radius a, and outer hollow conductor having inner radius b and outer radius c. There are equal and opposite currents, I, in the conductors. (i) Find the magnetic induction B at r within the inner conductor ($r<a$). (ii) Find B between two conductors ($a<r<b$). **(12)**

7. (a) Briefly explain the inadequacy of classical mechanics for which quantum mechanics is introduced. **(10)**

(b) Derive the one dimensional (i) time-dependent, and (ii) time independent Schrödinger equation of bound particle. **(26 2/3)**

(c) Define Hermitian operator with examples. Show that the Eigen values of Hermitian operator are real. **(10)**

8. (a) Briefly write down the statements of Kepler's laws of planetary motion and hence show that the angular momentum, L, is conserved. **(12)**

(b) Consider a moving particle confined in a box. Deduce the energy state equation of the particle using quantum mechanical approach. **(22 2/3)**

(c) Consider that an electron is placed in a box of 1.2 Å wide while another 10 g sized marble is placed in a box of 10 cm wide. Compute the permitted energy levels in both cases and explain why we do not experience the energy quantization. **(12)**

L-1/T-1/CSE **Date : 27/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **MATH 145** (Differential Calculus, Integral Calculus and Co-ordinate Geometry)

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) A function is defined in the way: $f(x)=\begin{cases} x, & 0<x<1 \\ 2-x & 1\le x\le 2 \\ -\frac{1}{2}x^2, & x>2 \end{cases}$. Discuss the continuity and differentiability of $f(x)$ at $x=1$ and 2. Also sketch the graph of $f(x)$. **(18)**

   (b) State and prove Leibnitz's theorem. If $y=\sin^{-1}x$ then find y_n for $x=0$. **(17)**

2. (a) State and prove Rolle's theorem. Suppose that two runners in a 100 m dash finish in a tie. Check whether they had the same velocity at least once during the race or not. Justify your answer. **(18)**

   (b) Find the Lagrange's form of remainder after n terms in the expansion of $e^{ax}\cos bx$ in powers of x. **(10)**

   (c) Evaluate $\lim_{x\to 0} x^{2\sin x}$ **(7)**

3. (a) Show that of all rectangles of given area, the square has the smallest area. **(10)**

   (b) If $u=x^2\tan^{-1}\frac{y}{x}-y^2\tan^{-1}\frac{x}{y}$, find the value of $\frac{\partial^2 u}{\partial x\partial y}$. **(10)**

   (c) Find the condition that the conics $ax^2+by^2=1$ and $a_1x^2+b_1y^2=1$ shall cut orthogonally. **(15)**

4. (a) Find the integral $\int_0^{\pi}\frac{x}{\sin x+1}dx$. **(11)**

   (b) Find Walli's formula for $\int_0^{\pi/2}\sin^m x\cos^n x\,dx$. **(12)**

   (c) Evaluate $\lim_{n\to\infty}\left\{\left(1+\frac{1}{n^2}\right)^{\frac{2}{n^2}}\left(1+\frac{2^2}{n^2}\right)^{\frac{4}{n^2}}\left(1+\frac{3^2}{n^2}\right)^{\frac{6}{n^2}}\cdots\cdots\left(1+\frac{n^2}{n^2}\right)^{\frac{2n}{n^2}}\right\}$. **(12)**

Contd P/2

MATH 145

SECTION - B

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

5. (a) Prove that $\int_0^{\pi/2} \frac{d\varphi}{\sqrt{1-\frac{1}{2}\sin^2\varphi}} = \frac{\left\{\Gamma\left(\frac{1}{4}\right)\right\}^2}{4\sqrt{\pi}}$. **(12)**

(b) Evaluate: $\int_0^1 \frac{dx}{(x+1)(x+2)\sqrt{x(1-x)}}$. **(10)**

(c) Evaluate: $\int_1^2 \int_0^{\sqrt{3}} \int_0^x \frac{x}{x^2+y^2}\, dy\, dx\, dz$. **(13)**

6. (a) Find the area enclosed by the cardioide r = a(1+sinθ). **(12)**

(b) Show that the total length of the curve $x^2(a^2-x^2) = 8a^2y^2$ is $\frac{\pi a}{\sqrt{2}}$. **(10)**

(c) Find the volume of the solid formed by revolving the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1, a>b$, about it's minor axis. **(13)**

7. (a) Transform the equation $9x^2+15xy+y^2+12x-11y-15=0$ so that the terms x, y and xy are absent. **(12)**

(b) Show that the equation $ax^2+2hxy+by^2+2gx+2fy+c=0$ represents two parallel lines if $\frac{a}{h}=\frac{h}{b}=\frac{g}{f}$ and then, the distance between them is $2\sqrt{\frac{g^2-ac}{a(a+b)}}$. **(13)**

(c) Tangents are drawn from the point (h,k) to the circle $x^2+y^2=a^2$. Prove that the area of the triangle formed by them and their chord of contact is **(10)**

$$\frac{a\left(h^2+k^2-a^2\right)^{3/2}}{\left(h^2+k^2\right)}$$

8. (a) Show that if tangents be drawn to the parabola $y^2-4ax=0$ from a point on the line $x+4a=0$, then their chord of contact will subtend a right angle at the vertex. **(12)**

(b) Reduce the equation $x^2-4xy+y^2+8x+2y-5=0$ to its standard form. **(10)**

(c) Show that the tangents to the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ at the ends of a chord which subtend a right angle at the centre intersect on the ellipse **(13)**

$$\frac{x^2}{a^4}+\frac{y^2}{b^4}=\frac{1}{a^2}+\frac{1}{b^2}.$$

L-1/T-1/CSE **Date: 21/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **ME 165** (Basic Mechanical 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**.

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

1. (a) Three cables are used to tether a balloon as shown in the Figure for Question No.1(a). Determine the vertical force $\vec{P}$ exerted by the balloon at A knowing that the tension in cable AD is 481 N. **(20)**

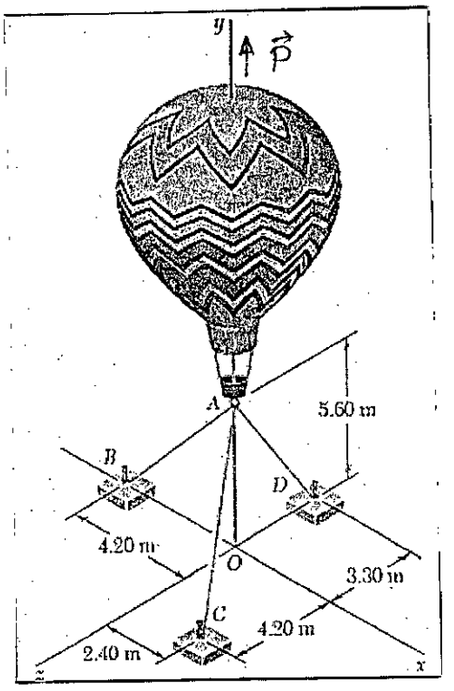

Figure for Question 1 (a)

(b) Four forces are applied to the machine component $ABDE$ as shown in the Figure for Que. No.1(b). Replace these forces by an equivalent force-couple system at A. **(15)**

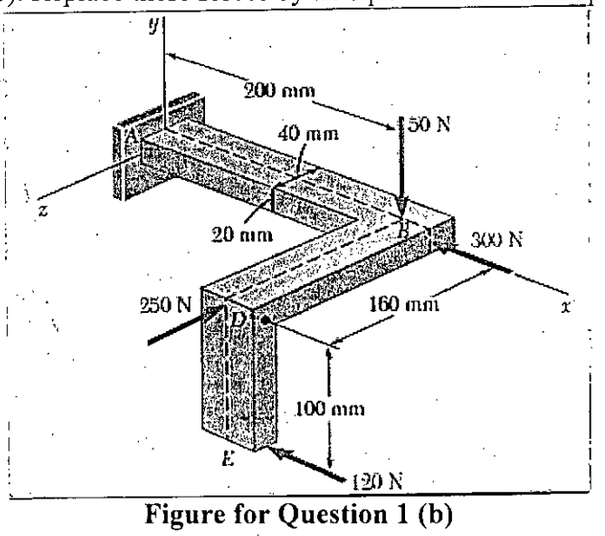

Figure for Question 1 (b)

Contd P/2

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2. (a) Determine the force in members *CD*, *CJ* and *GJ* as shown in the Figure for Ques. No. 2(a). Also state whether these members are in tension or compression. **(17)**

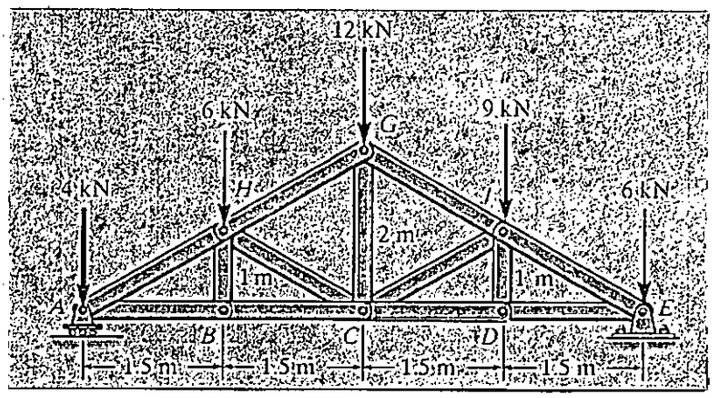

Figure for Question 2 (a)

(b) In the Figure for Ques. No. 2(b), a 2.4-m boom is held by a ball-and-socket joint at *C* and by two cables *AD* and *AE*. Determine the tension in each cable. **(18)**

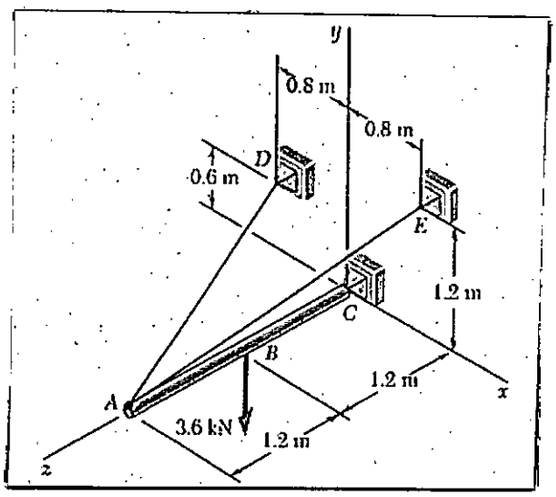

Figure for Question 2 (b)

3. (a) In the Figure for Que. No. 3 (a), block B moves downward with a constant velocity of 20 mm/s. At $t = 0$, block *A* is moving upward with a constant acceleration, and its velocity is 30 mm/s. Knowing that at $t = 3$ s the slider block *C* has moved 57 mm to the right, determine (i) the velocity of slider block *C* at $t = 0$, (ii) the accelerations of *A* and *C*, (iii) the change in position of block *A* after 5 s. **(17)**

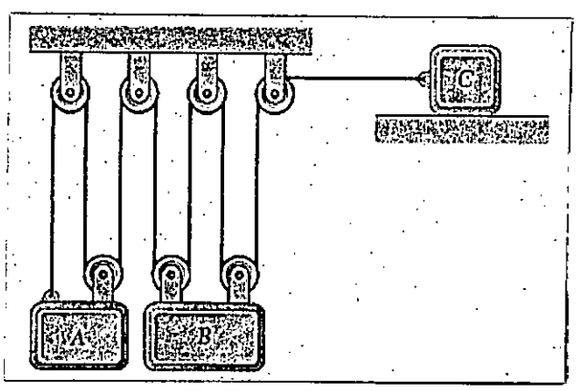

Figure for Question 3 (a)

Contd P/3

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Contd... Q. No. 3

(b) Two wires *AC* and *BC* are tied at *C* to a sphere which revolves at a constant speed *v* in the horizontal circle as shown in the Figure for Ques. No. 3(b). Determine the range of the allowable values of *v* if both wires are to remain taut and if the tension in wire *BC* is not to exceed 60 N. **(18)**

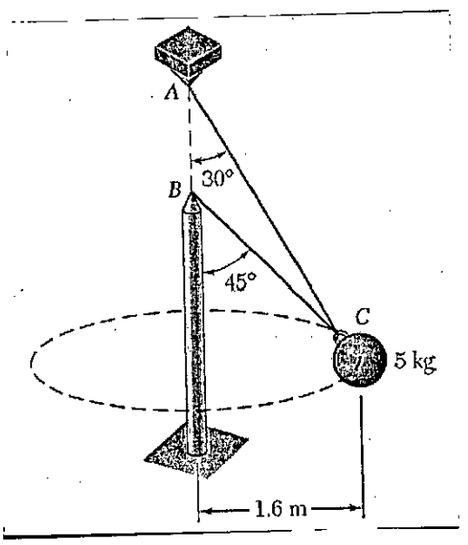

Figure for Question 3 (b)

4. (a) In the engine system shown in Figure for Que. No. 4(a), crank AB rotates with a constant angular velocity of 1000 rpm clockwise. Knowing that, l = 160 mm and b = 60 mm, determine the velocity of the piston P and the angular velocity of the connecting rod *BD* when $\theta = 60°$. **(20)**

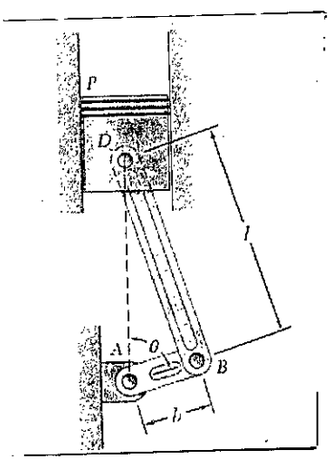

Figure for Question 4 (a)

(b) With the help of suitable diagrams or flowcharts write short notes on the following:
(i) Ocean thermal energy conversion (OTEC)
(ii) Hydroelectric energy **(15)**

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SECTION – B

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

5. (a) What is Dew Point Temperature? Draw the schematic diagram of chiller type Air Conditioning System. **(10)**

   (b) Air at 35^0C dry bulb temperature and 60% relative humidity flowing at 2 kg/s is mixed with air flowing at 4 kg/s and having conditions of 20^0C wet bulb temperature and 30^0C dry bulb temperature. Calculate the following properties of the final mixture: **(20)**

   (i) Absolute humidity
   (ii) Relative humidity
   (iii) Dry and wet bulb temperature
   (iv) Dew point
   (v) Enthalpy.

   (c) Explain briefly "Turbocharged and Supercharged" air intake system. **(5)**

6. (a) What is COP? Draw the schematic diagram of Vapor Absorption Refrigeration system and explain the processes involved in the system. **(15)**

   (b) Write the desirable properties of Refrigerants. **(5)**

   (c) A refrigerator uses refrigerant 134a as the working fluid and operates on an ideal vapor compression refrigeration cycle between 0.14 and 0.8 MPa. If the mass flow rate of the refrigerant is 0.05 kg/s. Determine- **(15)**

   (a) the rate of heat removal from the refrigerated space and the power input to the compressor,
   (b) the rate of heat rejection to the environment,
   (c) the COP of the refrigerator.

7. (a) What is Mean Effective Pressure (MEP)? Briefly explain the engine operation of 4 Stroke SI engine with schematic diagram. **(15)**

   (b) Draw a schematic diagram of cam operated valve. **(5)**

   (c) In a Diesel cycle, Compression begins at 0.1MPa, 40^0C and the compression ratio is 15. The heat added is 1.675MJ/kg and consider the value of C_v = 0.718 kJ/kg.K. Find: **(15)**

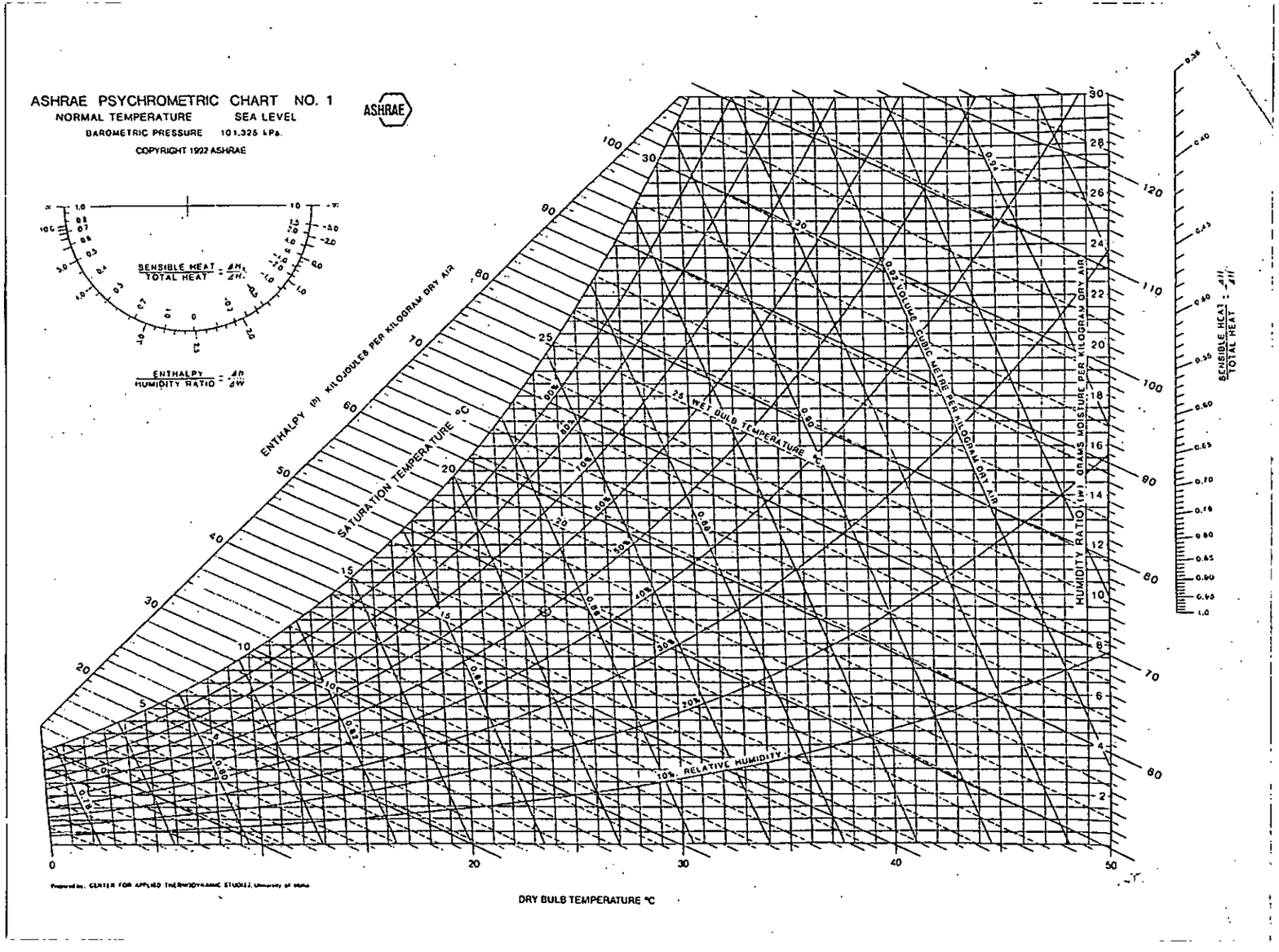
   (a) the maximum temperature in the cycle,
   (b) work done per kg of air
   (c) the cycle efficiency
   (d) the temperature at the end of the isentropic expansion
   (e) the cut-off ratio.

8. (a) Define payload. Briefly classify robots according to Japanese Industrial Robot Association (JIRA). **(10)**

   (b) With schematic diagram classify and explain different types of actuators. **(10)**

   (c) A point P $(7, 3, 2)^T$ is attached to a frame $(\bar{n}, \bar{o}, \bar{a})$ and is subjected to the transformations given below. Fine the coordinate to the point relative to the reference frame at the end of transformations. **(15)**

   Rotation of 90° about the z axis,
   Followed by a translation of [4, -3, 7],
   Followed by a rotation of 90° about the y axis.


ASHRAE PSYCHROMETRIC CHART NO. 1
NORMAL TEMPERATURE SEA LEVEL
BAROMETRIC PRESSURE 101.325 kPa.
COPYRIGHT 1992 ASHRAE
ASHRAE
SENSIBLE HEAT / TOTAL HEAT = ΔH / ΔH
ENTHALPY / HUMIDITY RATIO = Δh / Δw
ENTHALPY (h) KILOJOULES PER KILOGRAM DRY AIR
SATURATION TEMPERATURE °C
WET BULB TEMPERATURE °C
RELATIVE HUMIDITY
VOLUME CUBIC METRE PER KILOGRAM DRY AIR
HUMIDITY RATIO (w) GRAMS MOISTURE PER KILOGRAM DRY AIR
SENSIBLE HEAT / TOTAL HEAT
DRY BULB TEMPERATURE °C
Prepared by CENTER FOR APPLIED THERMODYNAMIC STUDIES, University of Idaho

Saturated refrigerant-134a—Temperature table

Temp., T °C	Sat. press., P_{sat} kPa	Specific volume, m³/kg: Sat. liquid, v_f	Specific volume, m³/kg: Sat. vapor, v_g	Internal energy, kJ/kg: Sat. liquid, u_f	Internal energy, kJ/kg: Evap., u_{fg}	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: Evap., s_{fg}	Entropy, kJ/kg·K: Sat. vapor, s_g
−40	51.25	0.0007054	0.36081	−0.036	207.40	207.37	0.000	225.86	225.86	0.00000	0.96866	0.96866
−38	56.86	0.0007083	0.32732	2.475	206.04	208.51	2.515	224.61	227.12	0.01072	0.95511	0.96584
−36	62.95	0.0007112	0.29751	4.992	204.67	209.66	5.037	223.35	228.39	0.02138	0.94176	0.96315
−34	69.56	0.0007142	0.27090	7.517	203.29	210.81	7.566	222.09	229.65	0.03199	0.92859	0.96058
−32	76.71	0.0007172	0.24711	10.05	201.91	211.96	10.10	220.81	230.91	0.04253	0.91560	0.95813
−30	84.43	0.0007203	0.22580	12.59	200.52	213.11	12.65	219.52	232.17	0.05301	0.90278	0.95579
−28	92.76	0.0007234	0.20666	15.13	199.12	214.25	15.20	218.22	233.43	0.06344	0.89012	0.95356
−26	101.73	0.0007265	0.18946	17.69	197.72	215.40	17.76	216.92	234.68	0.07382	0.87762	0.95144
−24	111.37	0.0007297	0.17395	20.25	196.30	216.55	20.33	215.59	235.92	0.08414	0.86527	0.94941
−22	121.72	0.0007329	0.15995	22.82	194.88	217.70	22.91	214.26	s237.17	0.09441	0.85307	0.94748
−20	132.82	0.0007362	0.14729	25.39	193.45	218.84	25.49	212.91	238.41	0.10463	0.84101	0.94564
−18	144.69	0.0007396	0.13583	27.98	192.01	219.98	28.09	211.55	239.64	0.11481	0.82908	0.94389
−16	157.38	0.0007430	0.12542	30.57	190.56	221.13	30.69	210.18	240.87	0.12493	0.81729	0.94222
−14	170.93	0.0007464	0.11597	33.17	189.09	222.27	33.30	208.79	242.09	0.13501	0.80561	0.94063
−12	185.37	0.0007499	0.10736	35.78	187.62	223.40	35.92	207.38	243.30	0.14504	0.79406	0.93911
−10	200.74	0.0007535	0.099516	38.40	186.14	224.54	38.55	205.96	244.51	0.15504	0.78263	0.93766
−8	217.08	0.0007571	0.092352	41.03	184.64	225.67	41.19	204.52	245.72	0.16498	0.77130	0.93629
−6	234.44	0.0007608	0.085802	43.66	183.13	226.80	43.84	203.07	246.91	0.17489	0.76008	0.93497
−4	252.85	0.0007646	0.079804	46.31	181.61	227.92	46.50	201.60	248.10	0.18476	0.74896	0.93372
−2	272.36	0.0007684	0.074304	48.96	180.08	229.04	49.17	200.11	249.28	0.19459	0.73794	0.93253
0	293.01	0.0007723	0.069255	51.63	178.53	230.16	51.86	198.60	250.45	0.20439	0.72701	0.93139
2	314.84	0.0007763	0.064612	54.30	176.97	231.27	54.55	197.07	251.61	0.21415	0.71616	0.93031
4	337.90	0.0007804	0.060338	56.99	175.39	232.38	57.25	195.51	252.77	0.22387	0.70540	0.92927
6	362.23	0.0007845	0.056398	59.68	173.80	233.48	59.97	193.94	253.91	0.23356	0.69471	0.92828
8	387.88	0.0007887	0.052762	62.39	172.19	234.58	62.69	192.35	255.04	0.24323	0.68410	0.92733
10	414.89	0.0007930	0.049403	65.10	170.56	235.67	65.43	190.73	256.16	0.25286	0.67356	0.92641
12	443.31	0.0007975	0.046295	67.83	168.92	236.75	68.18	189.09	257.27	0.26246	0.66308	0.92554
14	473.19	0.0008020	0.043417	70.57	167.26	237.83	70.95	187.42	258.37	0.27204	0.65266	0.92470
16	504.58	0.0008066	0.040748	73.32	165.58	238.90	73.73	185.73	259.46	0.28159	0.64230	0.92389
18	537.52	0.0008113	0.038271	76.08	163.88	239.96	76.52	184.01	260.53	0.29112	0.63198	0.92310

Saturated refrigerant-134a—Pressure table

Press., P kPa	*Sat. temp., T_{sat} °C*	*Specific volume, m³/kg: Sat. liquid, v_f*	*Specific volume, m³/kg: Sat. vapor, v_g*	*Internal energy, kJ/kg: Sat. liquid, u_f*	*Internal energy, kJ/kg: Evap., u_{fg}*	*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: Evap., s_{fg}*	*Entropy, kJ/kg·K: Sat. vapor, s_g*
60	*−36.95*	*0.0007098*	*0.31121*	*3.798*	*205.32*	*209.12*	*3.841*	*223.95*	*227.79*	*0.01634*	*0.94807*	*0.96441*
70	*−33.87*	*0.0007144*	*0.26929*	*7.680*	*203.20*	*210.88*	*7.730*	*222.00*	*229.73*	*0.03267*	*0.92775*	*0.96042*
80	*−31.13*	*0.0007185*	*0.23753*	*11.15*	*201.30*	*212.46*	*11.21*	*220.25*	*231.46*	*0.04711*	*0.90999*	*0.95710*
90	*−28.65*	*0.0007223*	*0.21263*	*14.31*	*199.57*	*213.88*	*14.37*	*218.65*	*233.02*	*0.06008*	*0.89419*	*0.95427*
100	*−26.37*	*0.0007259*	*0.19254*	*17.21*	*197.98*	*215.19*	*17.28*	*217.16*	*234.44*	*0.07188*	*0.87995*	*0.95183*
120	*−22.32*	*0.0007324*	*0.16212*	*22.40*	*195.11*	*217.51*	*22.49*	*214.48*	*236.97*	*0.09275*	*0.85503*	*0.94779*
140	*−18.77*	*0.0007383*	*0.14014*	*26.98*	*192.57*	*219.54*	*27.08*	*212.08*	*239.16*	*0.11087*	*0.83368*	*0.94456*
160	*−15.60*	*0.0007437*	*0.12348*	*31.09*	*190.27*	*221.35*	*31.21*	*209.90*	*241.11*	*0.12693*	*0.81496*	*0.94190*
180	*−12.73*	*0.0007487*	*0.11041*	*34.83*	*188.16*	*222.99*	*34.97*	*207.90*	*242.86*	*0.14139*	*0.79826*	*0.93965*
200	*−10.09*	*0.0007533*	*0.099867*	*38.28*	*186.21*	*224.48*	*38.43*	*206.03*	*244.46*	*0.15457*	*0.78316*	*0.93773*
240	*−5.38*	*0.0007620*	*0.083897*	*44.48*	*182.67*	*227.14*	*44.66*	*202.62*	*247.28*	*0.17794*	*0.75664*	*0.93458*
280	*−1.25*	*0.0007699*	*0.072352*	*49.97*	*179.50*	*229.46*	*50.18*	*199.54*	*249.72*	*0.19829*	*0.73381*	*0.93210*
320	*2.46*	*0.0007772*	*0.063604*	*54:92*	*176.61*	*231.52*	*55.16*	*196.71*	*251.88*	*0.21637*	*0.71369*	*0.93006*
360	*5.82*	*0.0007841*	*0.056738*	*59.44*	*173.94*	*233.38*	*59.72*	*194.08*	*253.81*	*0.23270*	*0.69566*	*0.92836*
400	*8.91*	*0.0007907*	*0.051201*	*63.62*	*171.45*	*235.07*	*63.94*	*191.62*	*255.55*	*0.24761*	*0.67929*	*0.92691*
450	*12.46*	*0.0007985*	*0.045619*	*68.45*	*168.54*	*237.00*	*68.81*	*188.71*	*257.53*	*0.26465*	*0.66069*	*0.92535*
500	*15.71*	*0.0008059*	*0.041118*	*72.93*	*165.82*	*238.75*	*73.33*	*185.98*	*259.30*	*0.28023*	*0.64377*	*0.92400*
550	*18.73*	*0.0008130*	*0.037408*	*77.10*	*163.25*	*240.35*	*77.54*	*183.38*	*260.92*	*0.29461*	*0.62821*	*0.92282*
600	*21.55*	*0.0008199*	*0.034295*	*81.02*	*160.81*	*241.83*	*81.51*	*180.90*	*262.40*	*0.30799*	*0.61378*	*0.92177*
650	*24.20*	*0.0008266*	*0.031646*	*84.72*	*158.48*	*243.20*	*85.26*	*178.51*	*263.77*	*0.32051*	*0.60030*	*0.92081*
700	*26.69*	*0.0008331*	*0.029361*	*88.24*	*156.24*	*244.48*	*88.82*	*176.21*	*265.03*	*0.33230*	*0.58763*	*0.91994*
750	*29.06*	*0.0008395*	*0.027371*	*91.59*	*154.08*	*245.67*	*92.22*	*173.98*	*266.20*	*0.34345*	*0.57567*	*0.91912*
800	*31.31*	*0.0008458*	*0.025621*	*94.79*	*152.00*	*246.79*	*95.47*	*171.82*	*267.29*	*0.35404*	*0.56431*	*0.91835*
850	*33.45*	*0.0008520*	*0.024069*	*97.87*	*149.98*	*247.85*	*98.60*	*169.71*	*268.31*	*0.36413*	*0.55349*	*0.91762*
900	*35.51*	*0.0008580*	*0.022683*	*100.83*	*148.01*	*248.85*	*101.61*	*167.66*	*269.26*	*0.37377*	*0.54315*	*0.91692*
950	*37.48*	*0.0008641*	*0.021438*	*103.69*	*146.10*	*249.79*	*104.51*	*165.64*	*270.15*	*0.38301*	*0.53323*	*0.91624*
1000	*39.37*	*0.0008700*	*0.020313*	*106.45*	*144.23*	*250.68*	*107.32*	*163.67*	*270.99*	*0.39189*	*0.52368*	*0.91558*
1200	*46.29*	*0.0008934*	*0.016715*	*116.70*	*137.11*	*253.81*	*117.77*	*156.10*	*273.87*	*0.42441*	*0.48863*	*0.91303*
1400	*52.40*	*0.0009166*	*0.014107*	*125.94*	*130.43*	*256.37*	*127.22*	*148.90*	*276.12*	*0.45315*	*0.45734*	*0.91050*
1600	*57.88*	*0.0009400*	*0.012123*	*134.43*	*124.04*	*258.47*	*135.93*	*141.93*	*277.86*	*0.47911*	*0.42873*	*0.90784*
1800	*62.87*	*0.0009639*	*0.010559*	*142.33*	*117.83*	*260.17*	*144.07*	*135.11*	*279.17*	*0.50294*	*0.40204*	*0.90498*
2000	*67.45*	*0.0009886*	*0.009288*	*149.78*	*111.73*	*261.51*	*151.76*	*128.33*	*280.09*	*0.52509*	*0.37675*	*0.90184*
2500	*77.54*	*0.0010566*	*0.006936*	*166.99*	*96.47*	*263.45*	*169.63*	*111.16*	*280.79*	*0.57531*	*0.31695*	*0.89226*
3000	*86.16*	*0.0011406*	*0.005275*	*183.04*	*80.22*	*263.26*	*186.46*	*92.63*	*279.09*	*0.62118*	*0.25776*	*0.87894*

Superheated refrigerant-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	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg·K
	P = 0.06 MPa (T_{sat} = −36.95°C)				P = 0.10 MPa (T_{sat} = −26.37°C)				P = 0.14 MPa (T_{sat} = −18.77°C)			
Sat.	0.31121	209.12	227.79	0.9644	0.19254	215.19	234.44	0.9518	0.14014	219.54	239.16	0.9446
−20	0.33608	220.60	240.76	1.0174	0.19841	219.66	239.50	0.9721				
−10	0.35048	227.55	248.58	1.0477	0.20743	226.75	247.49	1.0030	0.14605	225.91	246.36	0.9724
0 10	0.36476	234.66	256.54	1.0774	0.21630	233.95	255.58	1.0332	0.15263	233.23	254.60	1.0031
20	0.37893	241.92	264.66	1.1066	0.22506	241.30	263.81	1.0628	0.15908	240.66	262.93	1.0331
30	0.39302	249.35	272.94	1.1353	0.23373	248.79	272.17	1.0918	0.16544	248.22	271.38	1.0624
40	0.40705	256.95	281.37	1.1636	0.24233	256.44	280.68	1.1203	0.17172	255.93	279.97	1.0912
50	0.42102	264.71	289.97	1.1915	0.25088	264.25	289.34	1.1484	0.17794	263.79	288.70	1.1195
60	0.43495	272.64	298.74	1.2191	0.25937	272.22	298.16	1.1762	0.18412	271.79	297.57	1.1474
70	0.44883	280.73	307.66	1.2463	0.26783	280.35	307.13	1.2035	0.19025	279.96	306.59	1.1749
80	0.46269	288.99	316.75	1.2732	0.27626	288.64	316.26	1.2305	0.19635	288.28	315.77	1.2020
90	0.47651	297.41	326.00	1.2997	0.28465	297.08	325.55	1.2572	0.20242	296.75	325.09	1.2288
100	0.49032	306.00	335.42	1.3260	0.29303	305.69	334.99	1.2836	0.20847	305.38	334.57	1.2553
	0.50410	314.74	344.99	1.3520	0.30138	314.46	344.60	1.3096	0.21449	314.17	344.20	1.2814
	P = 0.18 MPa (T_{sat} = −12.73°C)				P = 0.20 MPa (T_{sat} = −10.09°C)				P = 0.24 MPa (T_{sat} = −5.38°C)			
Sat.	0.11041	222.99	242.86	0.9397	0.09987	224.48	244.46	0.9377	0.08390	227.14	247.28	0.9346
−10	0.11189	225.02	245.16	0.9484	0.09991	224.55	244.54	0.9380				
0 10	0.11722	232.48	253.58	0.9798	0.10481	232.09	253.05	0.9698	0.08617	231.29	251.97	0.9519
20	0.12240	240.00	262.04	1.0102	0.10955	239.67	261.58	1.0004	0.09026	238.98	260.65	0.9831
30	0.12748	247.64	270.59	1.0399	0.11418	247.35	270.18	1.0303	0.09423	246.74	269.36	1.0134
40	0.13248	255.41	279.25	1.0690	0.11874	255.14	278.89	1.0595	0.09812	254.61	278.16	1.0429
50	0.13741	263.31	288.05	1.0975	0.12322	263.08	287.72	1.0882	0.10193	262.59	287.06	1.0718
60	0.14230	271.36	296.98	1.1256	0.12766	271.15	296.68	1.1163	0.10570	270.71	296.08	1.1001
70	0.14715	279.56	306.05	1.1532	0.13206	279.37	305.78	1.1441	0.10942	278.97	305.23	1.1280
80	0.15196	287.91	315.27	1.1805	0.13641	287.73	315.01	1.1714	0.11310	287.36	314.51	1.1554
90	0.15673	296.42	324.63	1.2074	0.14074	296.25	324.40	1.1983	0.11675	295.91	323.93	1.1825
100	0.16149	305.07	334.14	1.2339	0.14504	304.92	333.93	1.2249	0.12038	304.60	333.49	1.2092
	0.16622	313.88	343.80	1.2602	0.14933	313.74	343.60	1.2512	0.12398	313.44	343.20	1.2356
	P = 0.28 MPa (T_{sat} = −1.25°C)				P = 0.32 MPa (T_{sat} = 2.46°C)				P = 0.40 MPa (T_{sat} = 8.91°C)			
Sat.	0.07235	229.46	249.72	0.9321	0.06360	231.52	251.88	0.9301	0.051201	235.07	255.55	0.9269
0	0.07282	230.44	250.83	0.9362								
10	0.07646	238.27	259.68	0.9680	0.06609	237.54	258.69	0.9544	0.051506	235.97	256.58	0.9305
20	0.07997	246.13	268.52	0.9987	0.06925	245.50	267.66	0.9856	0.054213	244.18	265.86	0.9628
30	0.08338	254.06	277.41	1.0285	0.07231	253.50	276.65	1.0157	0.056796	252.36	275.07	0.9937
40	0.08672	262.10	286.38	1.0576	0.07530	261.60	285.70	1.0451	0.059292	260.58	284.30	1.0236
50	0.09000	270.27	295.47	1.0862	0.07823	269.82	294.85	1.0739	0.061724	268.90	293.59	1.0528
60	0.09324	278.56	304.67	1.1142	0.08111	278.15	304.11	1.1021	0.064104	277.32	302.96	1.0814
70	0.09644	286.99	314.00	1.1418	0.08395	286.62	313.48	1.1298	0.066443	285.86	312.44	1.1094
80	0.09961	295.57	323.46	1.1690	0.08675	295.22	322.98	1.1571	0.068747	294.53	322.02	1.1369
90	0.10275	304.29	333.06	1.1958	0.08953	303.97	332.62	1.1840	0.071023	303.32	331.73	1.1640
100	0.10587	313.15	342.80	1.2222	0.09229	312.86	342.39	1.2105	0.073274	312.26	341.57	1.1907
110	0.10897	322.16	352.68	1.2483	0.09503	321.89	352.30	1.2367	0.075504	321.33	351.53	1.2171
120	0.11205	331.32	362.70	1.2742	0.09775	331.07	362.35	1.2626	0.077717	330.55	361.63	1.2431
130	0.11512	340.63	372.87	1.2997	0.10045	340.39	372.54	1.2882	0.079913	339.90	371.87	1.2688
140	0.11818	350.09	383.18	1.3250	0.10314	349.86	382.87	1.3135	0.082096	349.41	382.24	1.2942

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T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg·K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg·K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg·K
	P = 0.50 MPa (T_{sat} = 15.71°C)				P = 0.60 MPa (T_{sat} = 21.55°C)				P = 0.70 MPa (T_{sat} = 26.69°C)			
Sat.	0.041118	238.75	259.30	0.9240	0.034295	241.83	262.40	0.9218	0.029361	244.48	265.03	0.9199
20	0.042115	242.40	263.46	0.9383								
30	0.044338	250.84	273.01	0.9703	0.035984	249.22	270.81	0.9499	0.029966	247.48	268.45	0.9313
40	0.046456	259.26	282.48	1.0011	0.037865	257.86	280.58	0.9816	0.031696	256.39	278.57	0.9641
50	0.048499	267.72	291.96	1.0309	0.039659	266.48	290.28	1.0121	0.033322	265.20	288.53	0.9954
60	0.050485	276.25	301.50	1.0599	0.041389	275.15	299.98	1.0417	0.034875	274.01	298.42	1.0256
70	0.052427	284.89	311.10	1.0883	0.043069	283.89	309.73	1.0705	0.036373	282.87	308.33	1.0549
80	0.054331	293.64	320.80	1.1162	0.044710	292.73	319.55	1.0987	0.037829	291.80	318.28	1.0835
90	0.056205	302.51	330.61	1.1436	0.046318	301.67	329.46	1.1264	0.039250	300.82	328.29	1.1114
100	0.058053	311.50	340.53	1.1705	0.047900	310.73	339.47	1.1536	0.040642	309.95	338.40	1.1389
110	0.059880	320.63	350.57	1.1971	0.049458	319.91	349.59	1.1803	0.042010	319.19	348.60	1.1658
120	0.061687	329.89	360.73	1.2233	0.050997	329.23	359.82	1.2067	0.043358	328.55	358.90	1.1924
130	0.063479	339.29	371.03	1.2491	0.052519	338.67	370.18	1.2327	0.044688	338.04	369.32	1.2186
140	0.065256	348.83	381.46	1.2747	0.054027	348.25	380.66	1.2584	0.046004	347.66	379.86	1.2444
150	0.067021	358.51	392.02	1.2999	0.055522	357.96	391.27	1.2838	0.047306	357.41	390.52	1.2699
160	0.068775	368.33	402.72	1.3249	0.057006	367.81	402.01	1.3088	0.048597	367.29	401.31	1.2951
	P = 0.80 MPa (T_{sat} = 31.31°C)				P = 0.90 MPa (T_{sat} = 35.51°C)				P = 1.00 MPa (T_{sat} = 39.37°C)			
Sat.	0.025621	246.79	267.29	0.9183	0.022683	248.85	269.26	0.9169	0.020313	250.68	270.99	0.9156
40	0.027035	254.82	276.45	0.9480	0.023375	253.13	274.17	0.9327	0.020406	251.30	271.71	0.9179
50	0.028547	263.86	286.69	0.9802	0.024809	262.44	284.77	0.9660	0.021796	260.94	282.74	0.9525
60	0.029973	272.83	296.81	1.0110	0.026146	271.60	295.13	0.9976	0.023068	270.32	293.38	0.9850
70	0.031340	281.81	306.88	1.0408	0.027413	280.72	305.39	1.0280	0.024261	279.59	303.85	1.0160
80	0.032659	290.84	316.97	1.0698	0.028630	289.86	315.63	1.0574	0.025398	288.86	314.25	1.0458
90	0.033941	299.95	327.10	1.0981	0.029806	299.06	325.89	1.0860	0.026492	298.15	324.64	1.0748
100	0.035193	309.15	337.30	1.1258	0.030951	308.34	336.19	1.1140	0.027552	307.51	335.06	1.1031
110	0.036420	318.45	347.59	1.1530	0.032068	317.70	346.56	1.1414	0.028584	316.94	345.53	1.1308
120	0.037625	327.87	357.97	1.1798	0.033164	327.18	357.02	1.1684	0.029592	326.47	356.06	1.1580
130	0.038813	337.40	368.45	1.2061	0.034241	336.76	367.58	1.1949	0.030581	336.11	366.69	1.1846
140	0.039985	347.06	379.05	1.2321	0.035302	346.46	378.23	1.2210	0.031554	345.85	377.40	1.2109
150	0.041143	356.85	389.76	1.2577	0.036349	356.28	389.00	1.2467	0.032512	355.71	388.22	1.2368
160	0.042290	366.76	400.59	1.2830	0.037384	366.23	399.88	1.2721	0.033457	365.70	399.15	1.2623
170	0.043427	376.81	411.55	1.3080	0.038408	376.31	410.88	1.2972	0.034392	375.81	410.20	1.2875
180	0.044554	386.99	422.64	1.3327	0.039423	386.52	422.00	1.3221	0.035317	386.04	421.36	1.3124
	P = 1.20 MPa (T_{sat} = 46.29°C)				P = 1.40 MPa (T_{sat} = 52.40°C)				P = 1.60 MPa (T_{sat} = 57.88°C)			
Sat.	0.016715	253.81	273.87	0.9130	0.014107	256.37	276.12	0.9105	0.012123	258.47	277.86	0.9078
50	0.017201	257.63	278.27	0.9267								
60	0.018404	267.56	289.64	0.9614	0.015005	264.46	285.47	0.9389	0.012372	260.89	280.69	0.9163
70	0.019502	277.21	300.61	0.9938	0.016060	274.62	297.10	0.9733	0.013430	271.76	293.25	0.9535
80	0.020529	286.75	311.39	1.0248	0.017023	284.51	308.34	1.0056	0.014362	282.09	305.07	0.9875
90	0.021506	296.26	322.07	1.0546	0.017923	294.28	319.37	1.0364	0.015215	292.17	316.52	1.0194
100	0.022442	305.80	332.73	1.0836	0.018778	304.01	330.30	1.0661	0.016014	302.14	327.76	1.0500
110	0.023348	315.38	343.40	1.1118	0.019597	313.76	341.19	1.0949	0.016773	312.07	338.91	1.0795
120	0.024228	325.03	354.11	1.1394	0.020388	323.55	352.09	1.1230	0.017500	322.02	350.02	1.1081
130	0.025086	334.77	364.88	1.1664	0.021155	333.41	363.02	1.1504	0.018201	332.00	361.12	1.1360
140	0.025927	344.61	375.72	1.1930	0.021904	343.34	374.01	1.1773	0.018882	342.05	372.26	1.1632
150	0.026753	354.56	386.66	1.2192	0.022636	353.37	385.07	1.2038	0.019545	352.17	383.44	1.1900
160	0.027566	364.61	397.69	1.2449	0.023355	363.51	396.20	1.2298	0.020194	362.38	394.69	1.2163
170	0.028367	374.78	408.82	1.2703	0.024061	373.75	407.43	1.2554	0.020830	372.69	406.02	1.2421
180	0.029158	385.08	420.07	1.2954	0.024757	384.10	418.76	1.2807	0.021456	383.11	417.44	1.2676