ECE 376 - Test #2: Name

C-Programming on a PIC Processor

1) C Coding & Flow Charts (25 points) Write the corresponding C code for the flow chart shown to play a limited version of Black Jack • Start with zero points Draw a card (aces are always 11 points) ٠ • Compute your score • Keep playing until you have 16 or more points • If you go over 21 points, you lose assume a subroutine exists that returns a number 1..13 when called (different problem on this test) void main(void) { $ADCON1 = 0 \times 0F;$ TRISB = 0xFF; TRISC = 0;Score = 0;while(Score < 16) {</pre> Value = Draw_Card(13); if (Card == 1) Points = 11; elseif(Card > 10) Points = 10; else Points = Card; Score += Points; if (Score < 16) RC0 = !RC0;} if(Score > 21) RC1 = 1; else RC2 = 1;// Stop while(1); }



2) Subroutines: (25 points)

Write a subroutine

}

- Which is passed an integer, N
- The subroutine waits until you press and release button RB0
- When released, a random number (X) is returned in the range of 1 .. N

```
unsigned int Draw_Card(unsigned int N)
{
    unsigned int X;
    while(!RB0);
    while(RB0) {
        X = (X + 1) % N;
        }
        X = X + 1;
      return(X);
```

3) Analog Inputs (25 points)

Assume the A/D input to a PIC processor has the following hardware connection where R is a 3k thermistor where T is the temperature in degrees C

$$R = 2200 \cdot \exp\left(\frac{3800}{T + 273} - \frac{3800}{298}\right)\Omega$$

Let the R1 be your birthday

R1 = 900 + 100*month + day May 15th would give R1 = 1415 Ohms

If the A/D reads 872, determine

- The temperature in degrees C,
- The resistance, R,
- The voltage, V1, and
- The smallest change in termperature you can detect



R1	T (degees C)	R	V1	A/D Reading
900 + 100*mo + day		Thermistor - Ohms	Volts	
1415	-2.8039 C	8181.39 Ohms	4.2620 V	872

$$V_{1} = \left(\frac{872}{1023}\right) 5V = 4.2620V$$

$$V_{1} = \left(\frac{R}{R+1415}\right) 5V = 4.2620V$$

$$R = \left(\frac{V_{1}}{5V-V_{1}}\right) 1415\Omega$$

$$R = 8171.39\Omega$$

$$R = 8181.39\Omega = 2200 \cdot \exp\left(\frac{3800}{T+273} - \frac{3800}{298}\right)\Omega$$

$$T = -2.8039^{0}C$$

4) chi-squared test (10 points)

The high and low temperature in Fargo has been recorded each day since 1900 (124 years). So far this year, Fargo has hit a record high nine times in the past 71 days.

Use a chi-squared test to determine the probability that 2024 is no different than any other year (the probability of any given day being a record high is 1/124).

Case	p binomial distribution	np expected results	N actual results	Chi-Squared
Record High	1/124	0.5726	9	124.0374
Normal Year	123/124	70.4274	62	1.0084
			Total	125.0458

note: n = 71 (first 71 days of 2024

$$np = 71 \cdot p$$
$$\chi^2 = \left(\frac{(N - np)^2}{np}\right)$$

Degrees of Freedom = 1.000

two bins

From the chi-squared table, the probability is more than 99%

It is more than 99% likely that 2024 does not follow the behaviour of the past 124 years

From StatTrek, a probability of 0.99999 corresponds to a chi-squared value of 24.00. This is way beyond that.

Chi-Squared Table										
Probability of rejecting the null hypothesis										
dof	99%	95%	90%	80%	60%	40%	20%	10%	5%	1%
1	6.64	3.84	2.71	1.65	0.71	0.28	0.06	0.02	0	0
2	9.21	5.99	4.61	3.22	1.83	1.02	0.45	0.21	0.05	0.01
3	11.35	7.82	6.25	4.64	2.95	1.87	1.01	0.58	0.22	0.07
4	13.28	9.49	7.78	5.99	4.05	2.75	1.65	1.06	0.48	0.21
5	15.09	11.07	9.24	7.29	5.13	3.66	2.34	1.61	0.83	0.41
6	16.81	12.59	10.64	8.55	6.21	4.57	3.07	2.20	1.63	0.87
7	18.47	14.06	12.02	9.80	7.28	5.49	3.82	2.83	2.17	1.24

Chi Squared Table

5) t-Tests (15 points)

Hector Airport has been recording temperatures in Fargo since 1942 (82 years of data). The statistics for the high tempeature for the month of February are:

- mean = 42.9183F
- st dev = 7.0888F
- n = 82 (numer of data points)

In 2024, the high for February was 61.0F

Use a student t-test to determine the probability of being warmer than 61.0F in the month of February

Determine the t-score

$$t = \left(\frac{61.0F - 42.9183F}{7.0888F}\right) = 2.5507$$

There are 81 degrees of freedom (sample size = 82)

This t-score corresponds to a probability of 0.006

There is a 0.6% chance of any given February having a high of 61.0F or more

167:1 odds against

df \ p	0.001	0.0025	0.005	0.01	0.025	0.05	0.1	0.15	0.2
1	-636.619	-318.309	-63.6567	-31.8205	-12.7062	-6.3138	-3.0777	-1.9626	-1.3764
2	-31.5991	-22.3271	-9.9248	-6.9646	-4.3027	-2.92	-1.8856	-1.3862	-1.0607
10	-4.5869	-4.1437	-3.1693	-2.7638	-2.2281	-1.8125	-1.3722	-1.0931	-0.8791
20	-3.8495	-3.5518	-2.8453	-2.528	-2.086	-1.7247	-1.3253	-1.064	-0.86
30	-3.646	-3.3852	-2.75	-2.4573	-2.0423	-1.6973	-1.3104	-1.0547	-0.8538
40	-3.551	-3.3069	-2.7045	-2.4233	-2.0211	-1.6839	-1.3031	-1.05	-0.8507
50	-3.496	-3.2614	-2.6778	-2.4033	-2.0086	-1.6759	-1.2987	-1.0473	-0.8489
60	-3.4602	-3.2317	-2.6603	-2.3901	-2.0003	-1.6706	-1.2958	-1.0455	-0.8477
70	-3.435	-3.2108	-2.6479	-2.3808	-1.9944	-1.6669	-1.2938	-1.0442	-0.8468
80	-3.4163	-3.1953	-2.6387	-2.3739	-1.9901	-1.6641	-1.2922	-1.0432	-0.8461
90	-3.4019	-3.1833	-2.6316	-2.3685	-1.9867	-1.662	-1.291	-1.0424	-0.8456
100	-3.3905	-3.1737	-2.6259	-2.3642	-1.984	-1.6602	-1.2901	-1.0418	-0.8452

Student t-Table (area of tail)