UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2005/2006

April/Mei 2006

EEM 351 – REKABENTUK MEKATRONIK II

Masa : 3 jam

ARAHAN KEPADA CALON:

Sila pastikan bahawa kertas peperiksaan ini mengandungi **TIGA BELAS** muka surat termasuk **TIGA** mukasurat **Lampiran** bercetak sebelum anda memulakan peperiksaan ini.

Jawab **LIMA** soalan.

Jawab semua soalan dalam Bahasa Inggeris. Walau bagaimanapun, **SATU** soalan dibenarkan dijawab dalam Bahasa Malaysia.

...2/-

1. (a) Apakah komponen-komponen utama bagi sistem mekatronik? Jelaskan perkara-perkara penting yang perlu diambil perhatian oleh seorang pereka sebelum memulakan proses merekabentuk sistem mekatronik.

What are the main components of a mechatronic system? Explain the important points, which designer should keep in his mind before starting the design process of Mechatronic System?

(35%)

(b) Bagaimanakah anda mengklasifikasikan penderia? Apakah struktur logik bagi penderia? Jelaskan kelebihan-kelebihan penderia optik-gentian. Berikan skim, berpandukan kepada teknik ekstrinsik optik-gentian untuk pengukuran halaju satu mesin berputar berkelajuan tinggi dengan kejituan lebih baik dari 1% putaran.

How will you classify sensors? What is the logical structure of a sensor? Explain the advantages of Fiber-Optic Sensors. Give a scheme, based upon fiber-optic extrinsic technique, for the measurement of speed of a high speed rotating machine with an accuracy better than 1% of a revolution.

(35%)

(c) Jelaskan prinsip kerja penderia optic-gentian hakiki bagi pengukuran tekanan pada suhu tinggi (600°C) dengan lengkap dan terperinci.

Explain the working principle of an intrinsic fiber-optic sensor for the measurement of pressure at a high temperature (600°C) with complete details.

(30%)

...3/-

2. (a) Apakah perbezaan sifat-sifat penderia? Bagaimanakah ia digunakan dalam pemilihan penderia yang sesuai? Jelaskan dengan contoh yang sesuai, ciri-ciri perlakuan penderia.

What are the different attributes of sensors? How are they used in the selection of suitable sensor? Explain, with suitable example, the performance characteristics of sensors.

(50%)

(b) Jelaskan dengan gambarajah yang sesuai aspek-aspek rekabentuk bagi sistem pengukuran suhu optik-gentian jenis tak sentuh.

Explain with suitable diagram the design aspects of a non-contact type fiber-optic temperature measuring system.

(50%)

3. Tuliskan nota pendek bagi yang berikut:
Write short notes of the following:

(a) Faktor-faktor ergonomik dalam pemilihan penderia.
Ergonomic factors in the selection of sensors. (25%)

(b) Penukar analog ke digital
Analog to Digital Converters (25%)

(c) Penderia anjakan optik-gentian
Fiber-Optic displacement sensor (25%)

(d) Hala rekabentuk sistem mekatronik.
Design trends of Mechatronic System. (25%)

...4/-

4. (a) Anda dikehendaki memutarkan motor pelangkah ekakutub empat-fasa menggunakan satu mikropengawal dalam arah ikut-jam sebanyak 200 langkah.

You are required to rotate a four-phase unipolar stepper motor using a microcontroller in clockwise direction for 200 steps.

(i) Lukis satu litar skematik yang mengandungi transistor, satu motor pelangkah dan satu mikropengawal.

Draw a schematic of your circuit which consists of transistors, a stepper motor and a microcontroller.

(ii) Tulis satu aturcara dalam bahasa PicBasic Pro.
Write a program in PicBasic Pro language.

Dilampirkan: Konfigurasi pin 16F84, 16F877 dan set arahan PicBasic Pro
Attached: Pin configuration of 16F84, 16F877 and instruction set of PicBasic Pro.

(50%)

...5/-

(b) Seorang jurutera ingin menggunakan satu motor pelangkah digandingkan dengan satu kotak gear untuk memacu satu tali sawat berindeks untuk mencapai kebezajelasan sebanyak 1mm dan halaju maksima 10cm/s. Kotak gear tersebut adalah pengurang halaju dengan nisbah gear 3 kepada 1, dan tali sawat dipacu oleh 10-cm gelendong yang digandingkan kepada saf output bagi kotak gear.

An engineer wishes to use a stepper motor coupled to a gearbox to drive an indexed conveyer belt to achieve a linear resolution of 1mm and a maximum speed of 10cm/s. The gearbox is a speed reducer with a gear ratio of 3 to 1, and the conveyor is driven by a 10-cm drum attached to the output shaft of the gearbox.

(i) Apakah kebezajelasan minima diperlukan bagi motor pelangkah?
What is the minimum resolution required for the stepper motor?

(ii) Apakah kadar langkah diperlukan untuk mencapai halaju maksima pada kebezajelasan ini.
What step rate would be required to achieve the maximum speed at this resolution?

(30%)

...6/-

(c) Satu output digital mikropengawal (0V dan 5V) menggunakan transistor dwikutub sebagai suis untuk memacu satu beban 10 ohm. Transistor tersebut mempunyai h_{FE} sebanyak 50 dan $V_{CE(sat)}$ sebanyak 1V. Sekiranya bekalan voltan ialah 10V, apakah nilai perintang tapak yang sesuai.

A microcontroller digital output (0V and 5V) is using a bipolar transistor as a switch to drive a load of 10ohm. The transistor has h_{FE} of 50 and $V_{CE(sat)}$ of 1V. If supply voltage is 10V, what is the appropriate value of base resistor.

(20%)

5. (a) Terangkan tentang pengekod mutlak mengunakan kod gray dan kod perduaan asal. Lukiskan corak pada cakera dan isyarat yang dihasilkan untuk membantu penerangan anda. Tunjukkan bagaimana penggunaan kod gray dapat mengurangkan ketidakpastian data.

Explain about absolute encoder using gray and natural binary codes. Draw the disk track patterns and the generated signals to help your explanation. Show on how the use of gray code can reduce the data uncertainty.

(25%)

(b) Sekiranya ungkapan Boolean yang menghubungkan bit perduaan (B_i) kepada kod gray (G_i) adalah diberikan seperti berikut:

If the Boolean expressions that relate the binary bits (B_i) to the gray code bits (G_i) are given as follows:

...7/-

$B_3 = G_3$

$B_2 = B_3 \oplus G_2$

$B_1 = B_2 \oplus G_1$

$B_0 = B_1 \oplus G_0$

Bina satu litar menggunakan get-get ATAU ekslusif untuk melaksanakan ungkapan Boolean tersebut.
Build a circuit utilizing exclusive OR gates to perform the above Boolean expressions.

(15%)

(c) Dengan bantuan lakaran yang sesuai, beri
With the help of relevant sketches, give

(i) Tiga aplikasi suis mikro
Three applications of micro-switches

(ii) Tiga aplikasi suis reed
Three applications of reed switches.

(30%)

(d) Terangkan dengan lakaran gambarajah tentang penukar gerakan yang berikut:
Explain with the help of appropriate sketches about the following motion converters:

(i) Pemacu harmonik
Harmonic drive

...8/-

(ii) Pemacu geseran balutan dawai
Friction wire wrap drive

(iii) Sistem skrew-nut
Screw-nut system

(iv) Pemacu bolehubah kon dan kapi
Cone and pulley variable drive

(v) Kopp variator
Kopp variator (30%)

6. (a) Anda dikehendaki merekabentuk satu sistem pengukuran karbon monoksida (CO) berasaskan mikropengawal menggunakan PIC16F877. Sistem pengukuran ini mesti mengandungi unit penyesuaian isyarat dan unit paparan. Anda dicadangkan menggunakan kaedah proses rekabentuk bermula dengan kenyataan masalah awal sehingga mikropengawal teraturcara. Satu pemanas diperlukan untuk memanas pengesan serta gas karbon monoksida kepada suhu 200°C.

You are required to design a carbon monoxide (CO) microcontroller-based measurement system using PIC16F877. The measurement system must consist of signal conditioning and display units. You are suggested to use a methodical design process starting from the initial problem statement to a programmed microcontroller. A heater is required to heat the sensor and the carbon monoxide gas to 200°C.

...9/-

Berikut ialah ciri bagi pengesan karbon monoksida:
The following is the characteristic of the carbon monoxide sensor:

$$R_{sensor} = Ke^{\beta/C}$$

Di mana
Where

R_{sensor} ialah rintangan bagi pengesan dalam ohm pada 200°C
R_{sensor} is the resistance of the sensor in ohm at 200°C

K ialah 15600 ohm
K is 15600 ohm

β ialah 800 ppm
β *is 800 ppm*

C ialah kepekatan CO dalam ppm
C is the concentration of CO in ppm

(60%)

(b) (i) Beri lima tanda pengguna menghadapi masalah ergonomik dan lima sebab penyebab utama masalah ergonomik.

Give five symptoms of users having ergonomic problems and five main causes of ergonomic problems.

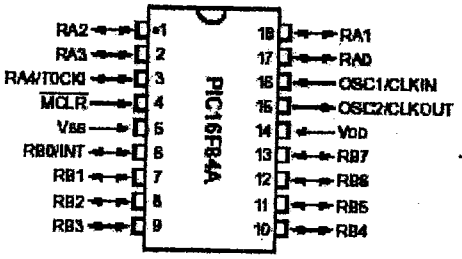
(10%)

(ii) Jelaskan tentang kepentingan Rekabentuk Perindustrian (ID) kepada sesuatu produk.
Explain on the importance of Industrial Design (ID) to a product?

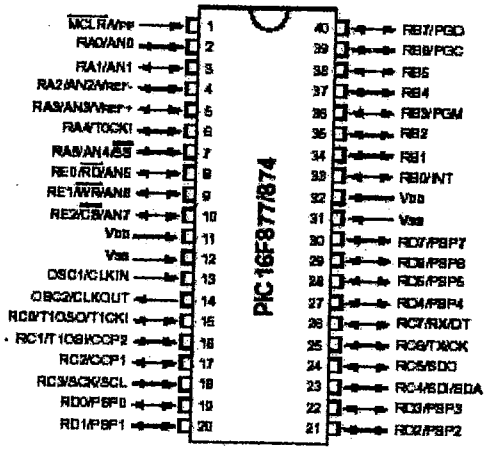
(10%)

...10/-

PDIP, SOIC



PIC16F84



PIC16F877

Table 7.5 PicBasic Pro statement summary

Statement	Description
@ assembly statement	Insert one line of assembly language code
ADCIN channel, var	Read the on-chip analog to digital converter (if there is one)
ASM . . . ENDASM	Insert an assembly language code section consisting of one or more statements
BRANCH index, [label1{, label2, . . .}]	Computed goto that jumps to a label based on index
BRANCHL index, [label1{, label2, . . .}]	Branch to a label that can be outside of the current page of code memory (for PICs with more than 2 k of program ROM)
BUTTON pin, down_state, auto_repeat_delay, auto_repeat_rate, countdown_variable, action_state, label	Read the state of a pin and perform debounce (by use of a delay) and autorepeat (if used within a loop)
CALL assembly_label	Call an assembly language subroutine
CLEAR	Zero all variables
CLEARWDT	Clear the watch-dog timer
COUNT pin, period, var	Count the number of pulses occurring on a pin during a period
DATA {@ location,} constant1{, constant2, . . .}	Define initial contents of the on-chip EEPROM (same as the EEPROM statement)
DEBUG item1{, item2, . . .}	Asynchronous serial output to a pin at a fixed baud rate
DEBUGIN {timeout, label,} [item1{,{item2, . . .}]	Asynchronous serial input from a pin at a fixed baud rate
DISABLE	Disable ON INTERRUPT and ON DEBUG processing
DISABLE DEBUG	Disable ON DEBUG processing
DISABLE INTERRUPT	Disable ON INTERRUPT processing
DTMFOUT pin, {on_ms, off_ms,} [tone1{, tone2, . . .}]	Produce touch tones on a pin
{EEPROM {@ location,} constant1{, constant2, . . .}}	Define initial contents of on-chip EEPROM (same as the DATA statement)
ENABLE	Enable ON INTERRUPT and ON DEBUG processing
ENABLE DEBUG	Enable ON DEBUG processing
ENABLE INTERRUPT	Enable ON INTERRUPT processing
END	Stop execution and enter low power mode
FOR count = start TO end {STEP {-} inc} {body statements} NEXT {count}	Repeatedly execute statements as count goes from start to end in fixed increment
FREQOUT pin, on_ms, freq1{, freq2}	Produce up to two frequencies on a pin
GOSUB label	Call a PicBasic subroutine at the specified label
GOTO label	Continue execution at the specified label
HIGH pin	Make pin output high
HSERIN {parity_label,} {time_out, label,} [item1{, item2, . . .}]	Hardware asynchronous serial input (if there is a hardware serial port)
HSEROUT [item1{, item2, . . .}]	Hardware asynchronous serial output (if there is a hardware serial port)
I2CREAD data_pin, clock_pin, control,{ address,} [var1{, var2, . . .}]{, label}	Read bytes from an external I^2C serial EEPROM device
I2CWRITE data_pin, clock_pin, control,{ address,} [var1{, var2, . . .}]{, label}	Write bytes to an external I^2C serial EEPROM device
IF log_comp THEN label	Conditionally jump to a label

IF log_comp THEN
true_statements
ELSE
false_statements
ENDIF
	Conditional execution of statements

INPUT pin	Make pin an input
LCDIN {address,} [var1{, var2, . . .}]	Read RAM on a liquid crystal display (LCD)
LCDOUT item1{, item2, . . .}	Display characters on LCD
{LET} var = value	Assignment statement (assigns a value to a variable)

Statement	Description
LOOKDOWN value, [const1{, const2, . . .}], var	Search constant table for a value
LOOKDOWN2 value, {test} [value1{, value2, . . .}], var	Search constant/variable table for a value
LOOKUP index, [const1{, const2, . . .}], var	Fetch constant value from a table
LOOKUP2 index, [value1{, value2, . . .}], var	Fetch constant/variable value from a table
LOW pin	Make pin output low
NAP period	Power down processor for a selected period of time
ON DEBUG GOTO label	Execute PicBasic debug subroutine at label after every statement if debug is enabled
ON INTERRUPT GOTO label	Execute PicBasic subroutine at label when an interrupt is detected
OUTPUT pin	Make pin an output
PAUSE period	Delay a given number of milliseconds
PAUSEUS period	Delay a given number of microseconds
{PEEK address, var}	Read byte from a register
{POKE address, var}	Write byte to a register
POT pin, scale, var	Read resistance of a potentiometer, or other variable resistance device, connected to a pin with a series capacitor to ground
PULSIN pin, state, var	Measure the width of a pulse on a pin
PULSOUT pin, period	Generate a pulse on a pin
PWM pin, duty, cycles	Output a pulse width modulated (PWM) pulse train to pin
RANDOM var	Generate a pseudo-random number
RCTIME pin, state, var	Measure pulse width on a pin
READ address, var	Read a byte from on-chip EEPROM
READCODE address, var	Read a word from code memory
RESUME {label}	Continue execution after interrupt handling
RETURN	Continue execution at the statement following last executed GOSUB
REVERSE pin	Make output pin an input or an input pin an output
SERIN pin, mode,{ timeout, label,} {{qual1, qual2, . . .},}{ item1{, item2, . . .}}	Asynchronous serial input (Basic Stamp 1 style)
SERIN2 data_pin{\flow_pin}, mode, {parity_label,} {timeout, label,} [item1{, item2, . . .}]	Asynchronous serial input (Basic Stamp 2 style)
SEROUT pin, mode, { item1{, item2, . . .}]	Asynchronous serial output (Basic Stamp 1 style)
SEROUT2 data_pin{\flow_pin}, mode, {pace,} {timeout, label,} [item1{, item2, . . .}]	Asynchronous serial output (Basic Stamp 2 style)
SHIFTIN data_pin, clock_pin, mode, [var1{\bits1} {, var2{\bits2}, . . .}]	Synchronous serial input
SHIFTOUT data_pin, clock_pin, mode, [var1{\bits1} {, var2{\bits2}, . . .}]	Synchronous serial output
SLEEP period	Power down the processor for a given number of seconds
SOUND pin, [note1, duration1{, note2, duration2, . . .}]	Generate a tone or white noise on a specified pin
STOP	Stop program execution
SWAP var1, var2	Exchange the values of two variables
TOGGLE pin	Change the state of an output pin
WHILE logical_comp statements	Execute code while condition is true
WEND	
WRITE address, value	Write a byte to on-chip EEPROM
WRITECODE address, value	Write a word to code memory
XIN data_pin, zero_pin, {timeout, label,} [var1{, var2, . . .}]]	Receive data from an external X-10 type device
XOUT data_pin, zero_pin, [house_code1\key_code1{\repeat1}{, house_code2\key_code2{\repeat2, . . .}]	Send data to an external X-10 type device

PicBasic Pro commands