UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2006/2007

April 2007

EEM 351 – REKABENTUK MEKATRONIK II

Masa : 3 jam

ARAHAN KEPADA CALON:

Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEBELAS (11)** muka surat termasuk **TIGA** muka surat **Lampiran** bercetak sebelum anda memulakan peperiksaan ini.

Kertas soalan ini mengandungi dua bahagian, **Bahagian A** dan **Bahagian B**.

Jawab **DUA (2)** soalan dalam **Bahagian A** dan **DUA (2)** soalan dalam **Bahagian B** dan **SATU (1)** soalan dari mana-mana Bahagian.

Jawab **LIMA (5)** soalan.

Gunakan dua buku jawapan yang diberikan supaya jawapan-jawapan bagi soalan-soalan Bahagian A adalah di dalam satu buku jawapan dan bagi Bahagian B di dalam buku jawapan yang lain.

Agihan markah bagi soalan diberikan disudut sebelah kanan soalan berkenaan.

Jawab semua soalan **Bahagian A** dalam Bahasa Inggeris, manakala semua soalan dalam **Bahagian B** boleh dijawab dalam Bahasa Malaysia.

...2/-

Bahagian A - Jawab DUA (2) soalan

1. (a) Apakah perbezaan-perbezaan di antara sistem mekatronik dengan sistem-sistem lazim yang lain? Kenapa rekabentuk sistem mekatronik lebih sukar daripada sistem-sistem yang lain? Apakah rekabentuk-rekabentuk metrik yang boleh membantu untuk menjayakan sesuatu rekabentuk sistem mekatronik?

What are the differences between Mechatronic system and other systems? Why the design of Mechatronic system is more difficult than other systems? What are the Design metrics which can help in the successful design of Mechatronic System?

(30%)

(b) Apakah proses-proses merekabentuk yang digunakan dalam rekabentuk-rekabentuk sistem mekatronik? Perjelaskan dengan kesesuaian contoh kebaikan-kebaikan dalam merekabentuk sistem-sistem mekatronik serempak?

What are the design processes used in the design of Mechatronic systems? Explain with suitable example the advantages of concurrent design of mechatronic systems.

(30%)

(c) Apakah kepentingan sesuatu penderia dalam sistem mekatronik? Bagaimanakah akan anda pilih dan merekabentuk penderia pada sesuatu sistem mekatronik? Perjelaskan dengan kesesuaian contoh.

What is the importance of sensors in mechatronic systems? How will you select and design a sensor in a particular mechatronic system? Explain it with suitable example.

(40%)

...3/-

2. (a) Apakah kebaikan-kebaikan menggunakan gentian optik dalam sistem komunikasi? Binakan Hukum Snell bagi perambatan cahaya di dalam gentian optik dan seterusnya pacukan ungkapan bagi sudut kritikal untuk jumlah pembalikan dalaman. Apakah peranan utama indek biasan bagi bahagian-bahagian yang berbeza dalam gentian optik? Nyatakan bukaan berangka dan separuh sudut atas bagi penerimaan kon (γ_c) untuk gentian kaca bila $n_1 = 1.50$ dan $n_2 = 1.48$.

What are the advantages of using Optical fiber in communication systems? Develop the Snell's Law for the propagation of light through Optical fiber and hence drive the expression for critical angle for total internal reflection. What is the role of refractive index of different parts of the optical fiber? Determine the numerical aperture and half top angle of the acceptance cone (γ_c) for a glass fiber when $n_1 = 1.50$ dan $n_2 = 1.48$.

(50%)

(b) Apakah kebaikan-kebaikan penderia gentian optik? Apakah perbezaan-perbezaan cara di mana gentian optik boleh digunakan untuk mengukur kuantiti-kuantiti bukan elektrik? Perjelaskan dengan kesesuaian gambarajah prinsip kerja bagi tahap permukaan sistem pengukuran. Bagaimana anda boleh meningkatkan kepekaannya? Apakah aplikasi-aplikasi yang menggunakannya?

What are the advantages of Fiber-Optic Sensors? What are the different ways in which Optical fiber can be used in the measurement of non-electrical quantities? Explain with suitable diagram the working principle of suitable diagram the working principle of surface level measuring system. How can you increase its sensitivity? What are its applications?

(50%)

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3. (a) Tuliskan nota ringkas bagi mana-mana EMPAT daripada topik-topik berikut:
Write short notes on any FOUR of the following topics:

(i) Fiber Bragg Gratings dan aplikasinya
Fiber Bragg Gratings and their applications (25%)

(ii) Penukar Analog ke Digital Flash
Flash Analog to Digital converters (25%)

(iii) Antara-muka man-machine
Man-machine interface (25%)

(iv) Ukuran bagi suhu oleh teknik-teknik gentian optik dan jenis tanpa-sentuh.
Measurement of temperature by Fiber optic, non-contact type techniques
(25%)

(v) Antara-muka bagi penderia bersama-sama litar Analog dan Digital.
Interfacing of sensors with Analog and Digital circuits
(25%)

Bahagian B - Jawab DUA (2) soalan

4. Pilih salah satu daripada tajuk di bawah dan seterusnya rekabentuk satu sistem berdasarkan mikropengawal. Rekabentuk anda mestilah mengandungi definasi masalah, pemilihan mikropengawal, pemilihan litar antaramuka, pemilihan bahasa penaturcaraan, lukisan skematik, carta-alir bagi program dan penulisan kod.

Choose one of the following titles and then design a microcontroller-based system. Your design should consist of problem definition, microcontroller selection, interfacing circuit selection, programming language selection, schematic drawing, program flowchart and code writing.

(i) *Sound Recorder*
(ii) *Vibrating Watch*
(iii) *Automated Segregation System based on the Object Colors*
(iv) *Automated Sweeper*
(v) *Intelligent Temperature Control System*
(vi) *Obstacle-Avoiding Robot*
(vii) *Intelligent Lock*
(viii) *Wheels of Fortune*
(ix) *Range Finder for Mobile Robot*
(x) *Propeller Clock*
(xi) *Telehome*
(xii) *Auto Parking System*

(100%)

2. Bincangkan dua (2) daripada tajuk-tajuk di bawah. Berikan jawapan anda menggunakan rajah, contoh, masalah serta cabaran yang wujud.

Discuss in details two (2) of the following topics, demonstrate your answers by using figures, examples, problems and challenges.

(i) Pengurusan Projek
Project Management

Kata kunci: Pergantungan tugas, carta Gantt, matrik struktur rekabentuk, carta PERT, organisasi dan perjawatan pasukan, belanjawan projek, pelaksanaan projek, tindakan pembetulan dan post-mortem.

Keywords: task dependencies, Gantt chart, design structure matrix, PERT chart, team staffing and organization, project budget, project execution, corrective action and post-mortem.

(ii) Pencontohsulungan
Prototyping

Kata kunci: jenis-jenis pencontohsulungan, tujuan pencontohsulungan, prinsip pencontohsulungan, teknologi pencontohsulungan dan perancangan untuk pencontohsulungan.

Keywords: type of prototypes, purpose of prototypes, Principles of prototype, prototyping technologies and planning for prototype.

(iii) Rekabentuk Industri
Industrial Design

Kata kunci: penilaian tentang keperluan rekabentuk industri, keperluan ergonomik, keperluan estetik, penilaian tentang kepentingan rekabentuk industri, proses rekabentuk industri dan kualiti bagi rekabentuk industri.

Keywords: Assessing the need for industrial design, ergonomics needs, aesthetic needs, assessing the importance of industrial design, industrial design process, assessing the quality of industrial design

(100%)

3. (a) Terangkan dengan bantuan gambarajah tentang penukar gerakan yang berikut:-

Explain with the help of appropriate sketches about the following motion converters:-

(i) Pemacu geseran balutan dawai
Friction wire wrap drive

(ii) Sistem skrew-nut
Screw-nut system

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

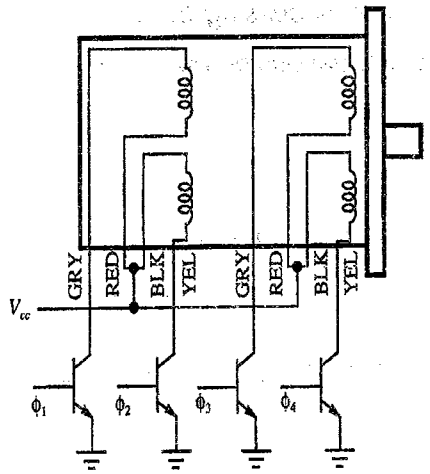
(45%)

(b) Anda dikehendaki memutarkan motor pelangkah ekakutub empat-fasa menggunakan sat 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.

Diberikan:

Given:



	Step	ϕ_1	ϕ_2	ϕ_3	ϕ_4
CW ↓	1	ON	OFF	ON	OFF
	2	ON	OFF	OFF	ON
CCW ↑	3	OFF	ON	OFF	ON
	4	OFF	ON	ON	OFF

(i) Lukiskan litar skematik mengandungi transistor-transistor, satu motor pelangkah dan satu mikropengawal.

Draw the schematic of your circuit consisting of transistors, a stepper motor and a microcontroller.

(ii) Lukiskan carta alir dan tulis satu aturcara dalam bahasa PicBasic Pro.

Write a program in PicBasic Pro language.

(55%)

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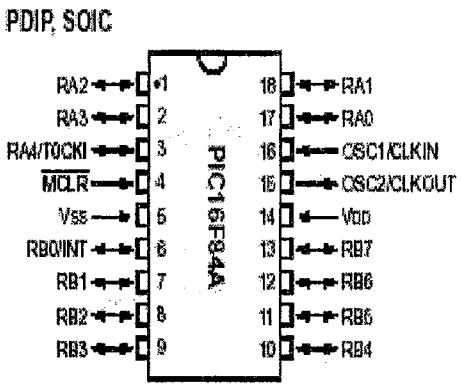
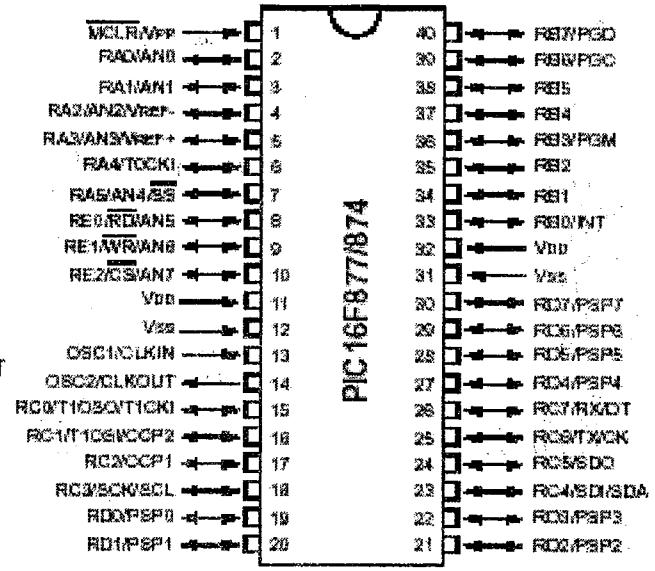


PIC16F84



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 WEND	Execute code while condition is true
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