UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Sekolah Pendidikan Profesional dan Pendidikan Berterusan (UTMSPACE)

2

DDPB

FINAL EXAMINATION / *PEPERIKSAAN AKHIR*
SEMESTER 1 – SESSION 2016 / 2017
PROGRAM KERJASAMA

COURSE CODE *KOD KURSUS*	:	DDPE 1142
COURSE NAME *NAMA KURSUS*	:	INSTRUMENTATION / *INSTRUMENTASI*
YEAR / PROGRAMME *TAHUN / PROGRAM*	:	1DDPE / K / P
DURATION *TEMPOH*	:	2 HOURS / 2 JAM
DATE *TARIKH*	:	OCT 2016

INSTRUCTION :
ARAHAN

1. This question paper consist of **FIVE (5)** questions.
   *Kertas soalan ini mengandungi **LIMA (5)** soalan.*

2. Answer **ALL** questions.
   *Jawab **SEMUA** soalan.*

(You are required to write your name and your lecturer's name on your answer script)
(Pelajar dikehendaki tuliskan nama dan nama pensyarah pada skrip jawapan)

STUDENT'S NAME / *NAMA PELAJAR*	:	.....
I.C NO. / *NO. K/PENGENALAN*	:	.....
YEAR / COURSE *TAHUN / KURSUS*	:	.....
LECTURER'S NAME *NAMA PENSYARAH*	:	.....
COLLEGE'S NAME *NAMA KOLEJ*	:	.....

This examination paper consists of **10** pages including the cover
*Kertas soalan ini mengandungi **10** muka surat termasuk kulit hadapan*

Q1 (a) Transducers are normally classified according to three characteristics. Explain briefly these three (3) characteristics.

Transduser lazimnya dikelaskan mengikut tiga ciri. Terangkan dengan ringkas tiga (3) ciri tersebut.

(6 marks/*markah*)

(b) Figure Q1(b) shows a circuit utilizing a resistance temperature detector (RTD) R_t. The RTD has a temperature coefficient of $\alpha = 0.0038K^{-1}$ and a resistance of 120 Ω at the reference temperature of 0°C. The battery voltage E = 9.0 V.

(i) Explain briefly the functions of RTD.

(ii) R_1 is set so that the output voltage V_o is 4.5 V at the reference temperature. Calculate R_1.

(iii) Calculate V_o when the temperature rises to 50°C.

(iv) A change in temperature causes the output voltage to change to 4.23 V. Calculate the new temperature.

Rajah Q1(b) menunjukkan litar yang menggunakan pengesan suhu rintangan (RTD) R_t. RTD tersebut mempunyai pekali suhu $\alpha = 0.0038\ K^{-1}$ dan rintangan 120 Ω pada suhu rujukan 0°C. Voltan bateri E = 9.0 V.

(i) Terangkan dengan ringkas bagaimana RTD berfungsi.

(ii) R_1 diset supaya voltan keluaran V_o ialah 4.5 V pada suhu rujukan. Kirakan R_1.

(iii) Kirakan V_o apabila suhu naik ke 50°C.

(iv) Perubahan suhu menyebabkan voltan keluaran berubah ke 4.23 V. Kirakan suhu yang baru.

$V_b = R_0(1 + \alpha\Delta T)$

$R_1 = R_0(1 + \alpha\Delta T)$

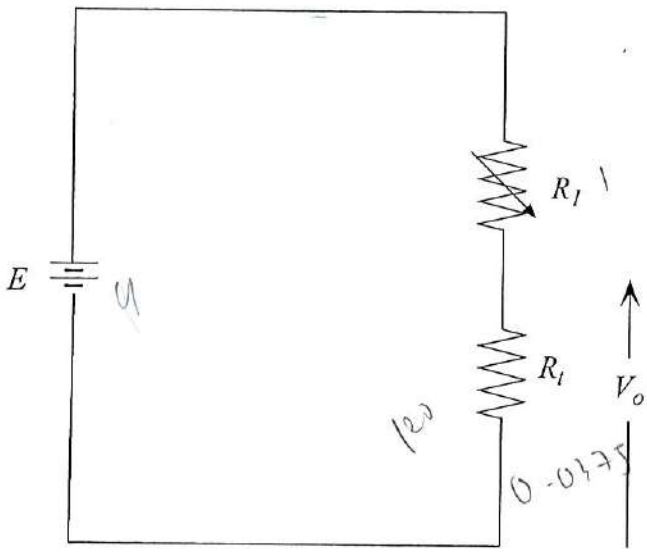


Figure Q1(b) / *Rajah Q1(b)*

(14 marks/*markah*)

Q2. (a) Describe the principle operation of one (1) of the following transducers. Illustrate your answer with appropriate diagrams.

(i) Linear variable differential transformer (LVDT)

(ii) Resistance temperature detector (RTD)

(iii) Photovoltaic cell

Huraikan prinsip pengendalian satu (1) daripada transduser berikut. Sertakan gambar rajah yang sesuai.

(i) Pengubah kebezaan bolehubah lelurus (LVDT)

(ii) Pengesan suhu berintangan (RTD)

(iii) Sel fotovolta.

(8 marks/*markah*)

(b) Appendix *A* shows the table for type *S* thermocouple.

(i) List two (2) advantages and two (2) disadvantages of the thermocouple as compared to other temperature transducers.

(ii) Type *S* thermocouple produces an output voltage of 10.949 mV. Determine the temperature at the hot junction when given the temperature of the cold junction is 20 °C.

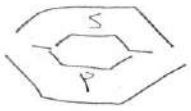
(iii) The temperature of the cold junction is adjusted to 10 °C. Determine the output voltage if the temperature of the hot junction does not change.

Lampiran A menunjukkan jadual pengganding suhu jenis S.

(i) Senaraikan dua (2) kelebihan dan dua (2) kekurangan pengganding suhu berbanding dengan transduser suhu lain.

(ii) Pengganding suhu jenis S menghasilkan voltan keluaran 10.949 mV. Tentukan suhu pada simpang panas jika suhu simpang sejuk ialah 20 °C.

(iii) *Suhu simpang sejuk dilaraskan ke 10 °C. Tentukan voltan keluaran jika suhu simpang panas tidak berubah.*



(12 marks/*markah*)

Q3. (a) (i) Explain briefly the role of signal conditioners in instrumentation systems.

(ii) Give a brief explanation of the Wheatstone bridge.

(i) Terangkan dengan ringkas peranan penyesuai isyarat dalam sistem instrumentasi.

(ii) Berikan penerangan ringkas tentang titi Wheatstone.

(6 marks/*markah*)

(b) Figure Q3(b) shows the circuit of a half Wheatstone bridge.

(i) Explain the difference between the half Wheatstone bridge and the full Wheatstone bridge.

(ii) Show that the Thevenin parameters for the half Wheatstone bridge between terminals c-d is given by

$$V_{TH} = \frac{\Delta R}{2R} E$$

$$R_{TH} \approx R$$

with the assumption that $\Delta R << R$.

(iii) Sketch the Thevenin equivalent circuit.

(iv) A galvanometer with internal resistance 100 Ω is used as a detector between terminals c-d. Calculate the current through the meter given that E = 2 V, R = 200 Ω and the resistance change is 2%.

Rajah Q3(b) menunjukkan litar titi separuh Wheatstone.

(i) Terangkan perbezaan titi separuh Wheatstone berbanding dengan titi penuh Wheatstone.

(ii) Tunjukkan bahawa parameter Thevenin bagi tetimbang tersebut antara terminal c-d diberikan oleh

$$V_{TH} = \frac{\Delta R}{2R} E$$

$$R_{TH} \approx R$$

dengan andaian bahawa $\Delta R << R$.

(iii) Lakarkan litar setara Thevenin.

(iv) Meter galvani dengan rintangan dalam 100 Ω digunakan sebagai pengesan antara terminal c-d. Kirakan arus yang mengalir melalui meter tersebut jika E = 2 V, R = 200 Ω , dan perubahan rintangan ialah 2%.

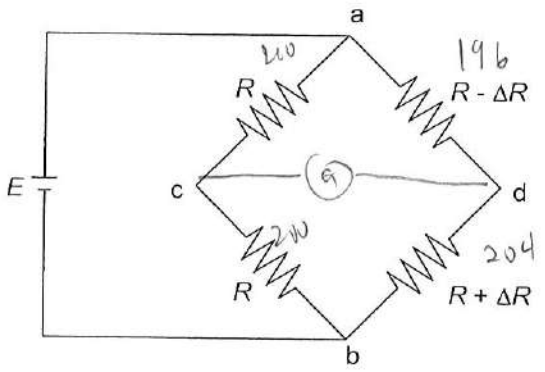


Figure Q3(b)/*Rajah Q3(b)*

(14 marks/*markah*)

Q4. (a) Figure Q4 (a) shows a Wein bridge circuit . Given R_1 = 5 kΩ, R_2 = 3 kΩ, R_3 = 4 kΩ, $C_1 = C_3$ = 2 μF.

(i) State the application of the Wein bridge.

(ii) Show that in the null condition, the frequency is given by

$$f = \frac{1}{2\pi\sqrt{C_1 C_3 R_1 R_3}}$$

(iii) Calculate the frequency.

Rajah Q4(a) menunjukkan litar titi Wein. Diberi R_1 = 5 kΩ, R_2 = 3 kΩ, R_3 = 4 kΩ, $C_1 = C_3$ = 2 μF.

(i) Nyatakan kegunaan titi Wein

(ii) Tunjukkan bahawa pada keadaan nol, frekuensi diberikan oleh,

$$f = \frac{1}{2\pi\sqrt{C_1 C_3 R_1 R_3}}$$

(iii) Kirakan frekuensi tersebut.

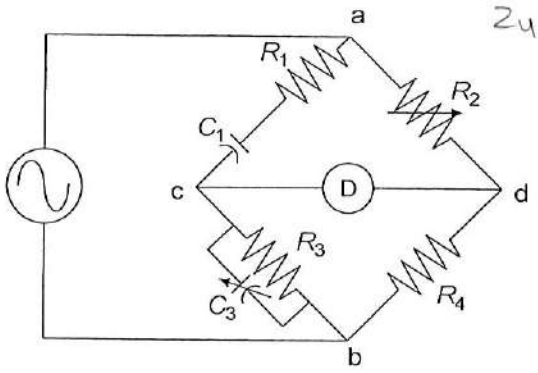


Figure Q4(a)/*Rajah Q4(a)*

(8 marks/*markah*)

(b) (i) Give four (4) examples of signal conditioners in an instrumentation system.

(ii) State the main application of a filter in an instrumentation system.

(iii) Name the four (4) types of filters used in signal conditioning and sketch their respective frequency responses.

(iv) In a measurement process, the signal frequency used is below 1 kHz, but the noise is at 1 MHz. Propose a suitable filter for the process. Determine the value of the cut-off frequency (f_c) if the voltage gain (V_o / V_{in}) is 1% at the maximum measurement frequency of 1 kHz.

(i) *Berikan empat (4) contoh penyesuai isyarat dalam sebuah sistem instrumentasi.*

(ii) *Nyatakan kegunaan utama penapis dalam sistem instrumentasi.*

(iii) *Namakan empat (4) jenis penapis yang digunakan untuk penyesuaian isyarat dan lakarkan sambutan frekuensi masing-masing.*

(iv) *Dalam suatu proses pengukuran, frekuensi isyarat yang digunakan di bawah 1 kHz, tetapi isyarat hingar berada pada 1MHz. Cadangkan penapis yang sesuai digunakan untuk proses tersebut. Dapatkan nilai frekuensi potong (f_c) jika gandaan voltan (V_o / V_{in}) ialah 1% pada frekuensi isyarat pengukuran maksimum 1 kHz.*

(12 marks/*markah*)

Q5. (a) Give the main reason why the use of data acquisition systems based on digital systems are widely used in instrumentation as compared to analogue systems.

Berikan sebab utama mengapa sistem perolehan data yang berasaskan sistem digit semakin banyak digunakan dalam pengalatan berbanding dengan sistem analog.

(6 marks/*markah*)

(b) The IEEE 488 bus is widely used in data communications. Explain the terms talker, listener and controller within the context of the IEEE 488 bus.

Bas IEEE 488 digunakan dengan meluas dalam perhubungan data. Terangkan istilah penutur, pendengar dan pengawal dalam konteks bas IEEE 488.

(6 marks/*markah*)

(c) The RS232 bus is also an interface used in digital systems. Explain briefly the difference between the RS232 bus and the IEEE 488 bus.

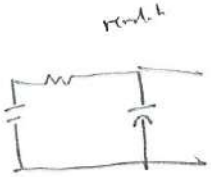
Bas RS232 juga merupakan antaramuka yang digunakan dalam sistem digit. Terangkan dengan ringkas perbezaan diantara bas RS232 dan bas IEEE 488.

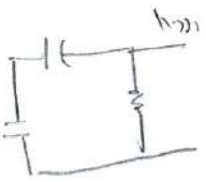
(8 marks/*markah*)

penyesuai isyarat

penapis

- penapis lulus tinggi
- penapis lulus rendah





APPENDIX *A* / *LAMPIRAN A*

TYPE *S* THERMOCOUPLE TABLE

JADUAL PENGGANDING SUHU JENIS S

Type S: Platinum-Platinum/10% Rhodium

	0	5	10	15	20	25	30	35	40	45
− 150										
− 100										
− 50										
− 0										
+ 0	0.000	0.028	0.056	0.084	0.113	0.143	0.173	0.204	0.235	0.266
50	0.299	0.331	0.364	0.397	0.431	0.466	0.500	0.535	0.571	0.607
100	0.643	0.680	0.717	0.754	0.792	0.830	0.869	0.907	0.946	0.986
150	1.025	1.065	1.166	1.146	1.187	1.228	1.269	1.311	1.352	1.394
200	1.436	1.479	1.521	1.564	1.607	1.650	1.693	1.736	1.780	1.824
250	1.868	1.912	1.956	2.001	2.045	2.090	2.135	2.180	2.225	2.271
300	2.316	2.362	2.408	2.453	2.499	2.546	2.592	2.638	2.685	2.731
350	2.778	2.825	2.872	2.919	2.966	3.014	3.061	3.108	3.156	3.203
400	3.251	3.299	3.347	3.394	3.442	3.490	3.539	3.587	3.635	3.683
450	3.732	3.780	3.829	3.878	3.926	3.975	4.024	4.073	4.122	4.171
500	4.221	4.270	4.319	4.369	4.419	4.468	4.518	4.568	4.618	4.668
550	4.718	4.768	4.818	4.869	4.919	4.970	5.020	5.071	5.122	5.173
600	5.224	5.275	5.326	5.377	5.429	5.480	5.532	5.583	5.635	5.686
650	5.738	5.790	5.842	5.894	5.946	5.998	6.050	6.102	6.155	6.207
700	6.260	6.312	6.365	6.418	6.471	6.524	6.577	6.630	6.683	6.737
750	6.790	6.844	6.897	6.951	7.005	7.058	7.112	7.166	7.220	7.275
800	7.329	7.383	7.438	7.492	7.547	7.602	7.656	7.711	7.766	7.821
850	7.876	7.932	7.987	8.042	8.098	8.153	8.209	8.265	8.320	8.376
900	8.432	8.488	8.545	8.601	8.657	8.714	8.770	8.827	8.883	8.940
950	8.997	9.054	9.111	9.168	9.225	9.282	9.340	9.397	9.455	9.512
1000	9.570	9.628	9.686	9.744	9.802	9.860	9.918	9.976	10.035	10.093
1050	10.152	10.210	10.269	10.328	10.387	10.446	10.505	10.564	10.623	10.682
1100	10.741	10.801	10.860	10.919	10.979	11.038	11.098	11.157	11.217	11.277
1150	11.336	11.396	11.456	11.516	11.575	11.635	11.695	11.755	11.815	11.875
1200	11.935	11.995	12.055	12.115	12.175	12.236	12.296	12.356	12.416	12.476
1250	12.536	12.597	12.657	12.717	12.777	12.837	12.897	12.957	13.018	13.078
1300	13.138	13.198	13.258	13.318	13.378	13.438	13.498	13.558	13.618	13.678
1350	13.738	13.798	13.858	13.918	13.978	14.038	14.098	14.157	14.217	14.277
1400	14.337	14.397	14.457	14.516	14.576	14.636	14.696	14.755	14.815	14.875
1450	14.935	14.994	15.054	15.113	15.173	15.233	15.292	15.352	15.411	15.471
1500	15.530	15.590	15.649	15.709	15.768	15.827	15.887	15.946	16.006	16.065
1550	16.124	16.183	16.243	16.302	16.361	16.420	16.479	16.538	16.597	16.657
1600	16.716	16.775	16.834	16.893	16.952	17.010	17.069	17.128	17.187	17.246
1650	17.305	17.363	17.422	17.481	17.539	17.598	17.657	17.715	17.774	17.832
1700	17.891	17.949	18.008	18.066	18.124	18.183	18.241	18.299	18.358	18.416
1750	18.474	18.532	18.590	18.648						

Mukasurat ini sengaja dibiarkan kosong

[This page is purposely left blank]