


FAKULTI : SEKOLAH PENGAJIAN SISWAZAH
TAJUK : RAYUAN PERAKUAN PELANJUTAN TEMPOH PENGHANTARAN PEMBETULAN TESIS KALI KETIGA

BUTIRAN PELAJAR	KETERANGAN PELAJAR	ULASAN DAN TINDAKAN FAKULTI	KELULUSAN																								
<p>NAMA : MOHD ASMU'I BIN MOHD AKIL</p> <p>NO K/P @ ISID : 841007115481</p> <p>NO MATRIK : PS113111</p> <p>PROGRAM : DOKTOR FALSAFAH (FIZIK)</p> <p>JENIS PENGAJIAN : PENYELIDIKAN</p> <p>BENTUK PENDAFTARAN : SEPENUH MASA</p> <p>PENAJA : -</p> <p>PENYELIA : PROF. MADYA DR. AMIRUDDIN BIN SHAARI</p> <p>PENYELIA BERSAMA : -</p> <p>BIL SEM: 18/16</p> <p>STATUS : VIVA</p> <p>TAJUK TESIS: SIMULATION OF OPTICAL AND ELECTRONIC CHARACTERISTIC OF TERAHERT QUANTUM CASCADE LASER</p> <p>MUKASURAT : 1/3</p>	<p>1.1 Kronologi kes pelajar seperti dibawah:</p> <table border="1"> <thead> <tr> <th>Bil</th> <th>Tarikh</th> <th>Perkara</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>02 Februari 2017</td> <td>Pelajar menghantar tesis bagi tujuan peperiksaan lisan (VIVA).</td> </tr> <tr> <td>2</td> <td>21 Jun 2017</td> <td>Peperiksaan lisan dijalankan dan pelajar mendapat keputusan c1 dan pembetulan perlu disemak oleh semua panel pemeriksa (dalam/ luar).</td> </tr> <tr> <td>3</td> <td>21 Jun 2018</td> <td>Tarikh akhir pelajar perlu menghantar pembetulan tesis ke SPS.</td> </tr> <tr> <td>4</td> <td>18 Julai 2018</td> <td>Pelajar menghantar permohonan untuk perlanjutan selama dua minggu dan diluluskan.</td> </tr> <tr> <td>5.</td> <td>5 Ogos 2018</td> <td>Pelajar menghantar pembetulan tesis.</td> </tr> <tr> <td>6.</td> <td>24 Disember 2018</td> <td>Pemeriksa dalam memberikan keputusan b2 setelah membuat pindaan dan pembetulan tesis seperti yang disenaraikan dalam laporan dan disahkan telah berbuat demikian oleh pemeriksa dalam/ luar berkenaan.</td> </tr> <tr> <td>7.</td> <td>22 Januari 2019</td> <td>Pemeriksa luar memberikan keputusan b2 setelah membuat pindaan dan pembetulan tesis seperti yang disenaraikan dalam laporan dan disahkan telah berbuat demikian oleh pemeriksa dalam/ luar berkenaan.</td> </tr> </tbody> </table>	Bil	Tarikh	Perkara	1	02 Februari 2017	Pelajar menghantar tesis bagi tujuan peperiksaan lisan (VIVA).	2	21 Jun 2017	Peperiksaan lisan dijalankan dan pelajar mendapat keputusan c1 dan pembetulan perlu disemak oleh semua panel pemeriksa (dalam/ luar).	3	21 Jun 2018	Tarikh akhir pelajar perlu menghantar pembetulan tesis ke SPS.	4	18 Julai 2018	Pelajar menghantar permohonan untuk perlanjutan selama dua minggu dan diluluskan.	5.	5 Ogos 2018	Pelajar menghantar pembetulan tesis.	6.	24 Disember 2018	Pemeriksa dalam memberikan keputusan b2 setelah membuat pindaan dan pembetulan tesis seperti yang disenaraikan dalam laporan dan disahkan telah berbuat demikian oleh pemeriksa dalam/ luar berkenaan.	7.	22 Januari 2019	Pemeriksa luar memberikan keputusan b2 setelah membuat pindaan dan pembetulan tesis seperti yang disenaraikan dalam laporan dan disahkan telah berbuat demikian oleh pemeriksa dalam/ luar berkenaan.	<p>1.1 Pelajar telah memohon untuk perlanjutan tempoh penghantaran pembetulan tesis selama 1 bulan dan mendapat sokongan dari penyelia.</p> <p>1.2 Pelajar yang berada pada semester maksimum mendapat penangguhan secara automatik berikutan pandemik COVID-19 bagi penghantaran pembetulan tesis seperti tertera di dalam pekeliling akademik bil. 3/ 2020.</p> <p>i. Dokumen seperti dilampiran.</p>	<p>Disokong / Tidak disokong</p> <p style="text-align: center;">  DR. NORAH BT MD NOOR <small>Timbalan Pengerusi Dewan/ID (Akademik) (Pembangunan Sistem & Persekitaran) Sekolah Pengajian Siswazah Universiti Teknologi Malaysia 81310 UTM Johor Bahru, Johor.</small> Cop Rasmi Tarikh : <u>23/8/2020</u> </p> <p>Setuju / Tidak Setuju (Ulasan)</p> <p>_____</p> <p>_____</p> <p>_____</p> <p style="text-align: center;">Pengerusi Mesyuarat Jawatankuasa Akademik Pengajian Siswazah Universiti (JAPSU) & Cop Rasmi</p> <p>Tarikh : _____</p>
Bil	Tarikh	Perkara																									
1	02 Februari 2017	Pelajar menghantar tesis bagi tujuan peperiksaan lisan (VIVA).																									
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7.	22 Januari 2019	Pemeriksa luar memberikan keputusan b2 setelah membuat pindaan dan pembetulan tesis seperti yang disenaraikan dalam laporan dan disahkan telah berbuat demikian oleh pemeriksa dalam/ luar berkenaan.																									

Bil	Tarikh	Perkara
8.	12 Ogos 2019	Tarikh akhir pembedulan pertama pelajar
9.	29 Ogos 2019	Pelajar menghantar pembedulan tesis ke SPS.
10.	17 November 2019	Pemeriksa dalam memberi pengesahan pembedulan tesis dengan sedikit pembedulan dan perlu disemak oleh penyelia. Pemeriksa mengesyorkan pelajar dianugerahkan Ijazah Doktor Falsafah.
11.	21 Oktober 2019	Pemeriksa luar memberikan semakan pembedulan dengan keputusan pelajar gagal membuat pembedulan ketiga dalam tempoh maksimum 3 bulan dan perlu disemak semula oleh pemeriksa.
12.	23 Februari 2020	Tarikh akhir bagi pembedulan kedua. Pelajar menghantar surat rayuan pelanjutan tempoh pembedulan kedua selama seminggu (1 Mac 2020) dan mendapat sokongan penyelia.
13.	01 Mac 2020	Pelajar menghantar pembedulan tesis.
14.	15 Julai 2020	Pemeriksa luar memberikan semakan pembedulan dengan keputusan pelajar gagal membuat pembedulan sebagaimana yang dicadangkan dan pelajar perlu membuat pembedulan ketiga dalam tempoh maksimum 1 bulan dan disemak semula oleh pemeriksa.
15.	12 Ogos 2020	Pelajar menghantar permohonan untuk perlanjutan penyerahan tesis kali ketiga selama 1 bulan dari tarikh penyerahan tesis (18 Ogos 2020) dan mendapat sokongan penyelia.

Disokong / Tidak disokong


DR. NORA BT MD NOOR
 Dekan/TP (Akademik) & Cop Rasmi
 Timbalan Pengerusi
 (Pembangunan Sistem & Profesional)
 Sekolah Pengajian Siswazah
 Universiti Teknologi Malaysia
 81310 UTM Johor Bahru, Johor.
 23/8/2020

Setuju / Tidak Setuju (Ulasan)

**Pengerusi Mesyuarat
 Jawatankuasa Akademik
 Pengajian Siswazah Universiti
 (JAPSU) &
 Cop Rasmi**

Tarikh : _____

- 1.2 Pelajar telah memohon perlanjutan penghantaran tesis bagi tujuan pemeriksaan semula tesis. Permohonan penangguhan di atas sebab yang berikut:
- i. Pelajar mempunyai kekangan masa kerana perlu menjaga anak yang sakit di hospital.

Disokong / Tidak disokong



Dekan/ID (Akademik)

DR. NORAH BINTI MD NOOR
Cop Rasmi
Timbalan Pengerusi
Pembangunan Sistem & Profesional
Sekolah Pengajian Siswazah
Universiti Teknologi Malaysia
81310 UTM Johor Bahru, Johor.

Setuju / Tidak Setuju
(Ulasan)

Pengerusi Mesyuarat
Jawatankuasa Akademik
Pengajian Siswazah Universiti
(JAPSU) &
Cop Rasmi

Tarikh : _____

UNIVERSITI TEKNOLOGI MALAYSIA

UTM.J.08.00/10.12/2 Jld.9 (27)

5 April 2020

11 Syaaban 1441

PEKELILING AKADEMIK BIL. 3/2020

JABATAN TIMBALAN NAIB CANSOLOR (AKADEMIK & ANTARABANGSA)

**PENAMBAHAN SATU SEMESTER TANGGUH PENGAJIAN BAGI PELAJAR DOKTOR FALSAFAH,
SARJANA PENYELIDIKAN YANG BERADA PADA SEMESTER MAKSIMUM SERTA PELAJAR
BERSTATUS PEPERIKSAAN BERIKUTAN PANDEMIK COVID-19**

Universiti Teknologi Malaysia (UTM) melalui Mesyuarat Senat Bil. 7 2019 /2020 pada 25 Mac 2020 telah meluluskan penambahan satu (1) semester tangguh pengajian yang tidak dikira bagi pelajar Sarjana Penyelidikan dan Doktor Falsafah (Penyelidikan dan Mod Campuran) yang berada pada semester maksimum pengajian serta status 'Peperiksaan' pada Semester II, Sesi 2019/2020 akibat dari pandemic COVID-19.

2. Pelajar Doktor Falsafah yang berada pada semester 16/16, pelajar Sarjana Penyelidikan yang berada pada semester 8/8 dan pelajar yang berstatus 'Peperiksaan' pada Semester II, Sesi 2019/2020 akan diberikan penangguhan secara automatik berikutan kesulitan yang dihadapi akibat dari pandemik COVID-19. Dengan penambahan satu (1) semester khas ini, pelajar perlu menghantar tesis dan pembetulan tesis dalam tempoh Semester I, Sesi 2020/2021.
3. Walau bagaimanapun, pihak Sekolah Pengajian Siswazah tiada halangan sekiranya pelajar ingin menghantar tesis pada semester semasa setelah memenuhi semua syarat penghantaran tesis yang telah ditetapkan.
4. Pertambahan semester ini adalah tanda keprihatinan pihak Universiti terhadap pelajar yang menghadapi kesulitan dalam menjalankan aktiviti penyelidikan disebabkan pandemik ini.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA KERANA ALLAH"

Saya yang menjalankan amanah,



(PROF. DATUK. IR. DR. WAHID BIN OMAR)

Naib Canselor

12 Ogos 2020

Dr. Norah binti Md Noor
Timbalan Pengerusi (Pembangunan Sistem & Profesional)
Sekolah Pengajian Siswazah,
Universiti Teknologi Malaysia,
81310 UTM Johor Bahru,
Johor

Y. Bhg. Dr.,

RAYUAN PELANJUTAN PENYERAHAN TESIS PEMBETULAN KALI KETIGA BAGI PROGRAM IJAZAH KEDOKTORAN

Adalah saya dengan hormatnya merujuk perkara di atas.

2. Merujuk kepada perkara di atas dan surat bertarikh 16 Julai 2020 (UTM. J. 10.01/14.14/1/6/3/16 Jld 6 (8)), saya Mohd Asmu'i Bin Mohd Akil (PS113111) ingin memohon pelanjutan penyerahan tesis pembetulan kali ketiga selama **sebulan** dari tarikh penyerahan (18 Ogos 2020) kepada tarikh baru iaitu **18 September 2020**.


3. Sehubungan dengan itu, setelah berbincang dengan penyelia, pelanjutan ini amat diperlukan kerana saya masih memerlukan sedikit masa lagi untuk memurnikan penulisan tesis termasuk pengesahan pembetulan dari penyelia. Sebagai makluman, saya mengalami kesukaran untuk meneruskan kerja-kerja pembetulan tesis kali ketiga ini kerana pada 5 Ogos 2020 (*lampiran 1*) yang lalu, seorang anak saya yang berumur 4 tahun telah dimasukkan ke hospital disebabkan masalah kesihatan. Sehingga kehari ini beliau masih berada dalam rawatan dan pemantauan pihak hospital. Hal ini menyebabkan saya dan isteri bergilir-gilir menjaganya di hospital. Adalah sukar untuk saya kekal fokus menyiapkan pembetulan tesis ini dimana pada masa yang sama saya perlu menguruskan anak yang sedang sakit. Sepanjang tempoh pembetulan ketiga yang telah diberikan ini, saya telah menggunakan sepenuh usaha saya untuk menyiapkan pembetulan seperti yang telah dicadangkan oleh pihak pemeriksa.

Diharap pihak Y. Bhg. Dr. dapat memahami keadaan dihadapi saya kini dan mempertimbangkan rayuan ini sewajarnya. Segala kerjasama didahului dengan ucapan ribuan terima kasih.

Yang benar,



Mohd Asmu'i Bin Mohd Akil (PS113111)
No 12, Jalan Utama 16,
Taman Mutiara Rini,
81300 Skudai, Johor
019-9676339



Dr. Amiruddin Shaari
Assoc. Prof.
Physics Department
Faculty of Science
Universiti Teknologi Malaysia
81310 UTM Johor Bahru



HOSPITAL SULTANAH AMINAH
80100 JOHOR BAHRU

No. Tel : 07 - 2257000 ext 2614
No. Faks : 07 - 2242594



Paediatrics Surgical Department
Hospital Sultanah Aminah
Johor Bahru

9th August 2020

To:-
Pengarah Jabatan Fizik,
Fakulti Sains
Universiti Teknologi Malaysia
81310 Skudai Johor

PATIENT'S NAME : Muhammad Anas bin Mohd Asmu'i
RN : 1938407
I/C : 160412-14-1241
GUARDIAN'S NAME : Norehan binti Mohd Nor
GUARDIAN'S I/C : 851230-12-5032

Above patient was admitted to East 5 Pediatric, HSAJB on the 05/08/2020 until now for treatment.
Patient's mother is required to accompany patient in ward.

Kindly do the needful for the patient and the parents. Thank you.

DR. SITI NUR ANIQAH BINTI MO HANAF
PEGAWAI PERUBATAN
NO PENDAFTARAN MMC (S) 77604
HOSPITAL SULTANAH AMINAH
JOHOR BAHRU

.....
East 5 Pediatric,
Hospital Sultanah Aminah,
Johor Bahru.



LAPORAN PENILAIAN OLEH PEMERIKSA
IJAZAH DOKTOR FALSAFAH MELALUI PENYELIDIKAN
(EXAMINERS' REPORT FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY BY RESEARCH)

Tajuk Tesis : **MODELLING OF OPTICAL AND ELECTRONIC CHARACTERISTICS FOR BROADBAND ALUMINIUM GALLIUM ARSENIDE TERAHERTZ QUANTUM CASCADE LASER**
(Title of Thesis)

Nama Pelajar : **MOHD ASMU'I BIN MOHD AKIL**
(Name of Candidate)

Nama Penyelia Utama : **DR. AMIRUDDIN BIN SHAARI**
(Name of Main Supervisor)

Kami, sebagai Panel Pemeriksa, telah menilai tesis di atas dan mengadakan ujian lisan untuk ijazah kedoktoran (We, the Panel of Examiners, have successfully evaluated the above thesis and examined him/her for the degree of Doctor of Philosophy) pada (on) dan mencapai satu keputusan seperti berikut: (and arrived at the following decision:)

A: KEPUTUSAN/RESULT

KEPUTUSAN VIVA (Decision:)	TEMPOH PEMBETULAN TESIS: (Duration of corrections:)	TESIS YANG TELAH DIBETULKAN PERLU DISAHKAN OLEH: (The corrected thesis will be verified and certified by:)	Sila tanda (/)
a	Tiada pembetulan/no correction	Penyelia/Supervisor	
b1	Maksimum 3 bulan (Maximum 3 months)	Penyelia/Supervisor	
b2	Maksimum 6 bulan [Maximum 6 months]	Pemeriksa Dalam/Internal Examiner	
		Pemeriksa Luar/External Examiner	
c1	Maksimum 12 bulan [Maximum 12 months] Pemeriksaan semula tesis [Thesis Reexamination]	Pemeriksa Luar dan Dalam [External and Internal Examiners]	/
c2	Maksimum 12 bulan [Maximum 12 months] Pemeriksaan semula tesis dan viva [Thesis reexamination and reviva]	Pemeriksa Luar dan Dalam [External and Internal Examiners]	
d	3 Bulan/3 months)	Penyelia/Supervisor	
e	Gagal [Fail]	-	

B. PERAKUAN PANEL PEMERIKSA

	NAMA/[NAME]	TANDATANGAN/[SIGNATURE]	TARIKH/[DATE]
PEMERIKSA LUAR [EXTERNAL EXAMINER]	PROF. DR. MOHD KAMIL ABD. RAHMAN		21/06/2017
PEMERIKSA LUAR 2 EXTERNAL EXAMINER 2			
PEMERIKSA DALAM 1 INTERNAL EXAMINER 1	PROF. MADYA DR. YUSOF BIN MUNAJAT		21/06/2017
PEMERIKSA DALAM 2 INTERNAL EXAMINER 2			
PENGERUSI [CHAIRMAN]	PROF. DR. NORIAH BINTI BIDIN		21/06/2017
PEMBANTU PENERUSI [ASST. CHAIRMAN]	DR. HUSNI HANI JAMEELA BINTI SAPINGI		21/06/2017



**LAPORAN PENILAIAN OLEH PEMERIKSA
IJAZAH DOKTOR FALSAFAH MELALUI PENYELIDIKAN
(EXAMINERS' REPORT FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY BY RESEARCH)**

C. MERIT/MERIT YA/YES TIDAK/NO

- Calon adalah cemerlang untuk ijazah ini dan dianugerahkan ijazah dengan merit.
The candidate is outstanding for this degree and should be awarded the degree with merit.
- Calon layak dianugerahkan dengan 'Merit' sekiranya keputusan peperiksaan lisan adalah A atau B1 sahaja.
The candidate may be awarded with 'Merit' provided that the result of viva-voce session is A or B1 only.

D. PERNYATAAN LAIN:

nil:

E. PERAKUAN PANEL PEMERIKSA

	NAMA [NAME]	TANDATANGAN [SIGNATURE]	TARIKH [DATE]
PEMERIKSA LUAR [EXTERNAL EXAMINER]	PROF. DR.MOHD KAMIL ABD. RAHMAN		21/06/2017
PEMERIKSA LUAR 2 EXTERNAL EXAMINER 2			
PEMERIKSA DALAM 1 INTERNAL EXAMINER 1	PROF. MADYA DR.YUSOF BIN MUNAJAT		21/06/2017
PEMERIKSA DALAM 2 INTERNAL EXAMINER 2			
PENGERUSI [CHAIRMAN]	PROF.DR.NORIAH BINTI BIDIN		21/06/2017
PEMBANTU PENGERUSI [ASST. CHAIRMAN]	DR. HUSNI HANI JAMEELA BINTI SAPINGI		21/06/2017

**SEKOLAH PENGAJIAN SISWAZAH
UNIVERSITI TEKNOLOGI MALAYSIA
LAPORAN Pengerusi Doktor Falsafah / IJAZAH SARJANA
(CHAIRMAN REPORT OF DOCTOR OF PHILOSOPHY / MASTER OF PHILOSOPHY)**


TARIKH (Date) : 21/06/2017

MASA (Time) : 9.00 pagi
TEMPAT (Venue) : Bilik Viva 1
Sekolah Pengajian Siswazah, (School of Graduate Studies)
Tingkat 2, Blok F54 (2nd floor, Block F54)
UTM, Johor Bahru

NAMA PELAJAR (Name of Student) : Mohd Asmu'i Bin Mohd Akil
PROGRAM (Programme) : Doktor Falsafah (Fizik)
FAKULTI (Faculty) : Fakulti Sains

PENGERUSI (Chairman) : Prof. Dr. Noriah Binti Bidin

PEMBANTU PENERUSI (Assistant Chairman) : Dr. Husni Hani Jameela binti Sapongi

PEMERIKSA LUAR (External Examiner) : Prof. Dr. Mohd Kamil Abd. Rahman 

PEMERIKSA DALAM (Internal Examiner) : Prof. Madya Dr. Yusof Bin Munajat

TAJUK (Title) : Modelling Of Optical And Electronic Characteristics For
Broadband Aluminium Gallium Arsenide Terahertz
Quantum Cascade Laser

KOMEN SELEPAS VIVA

(The following are comments from the Viva Session)

TAJUK BARU (New Title) :

Seperti yang dicadangkan oleh Panel Pemeriksa (As proposed by Panel of Examiner) jika ada, (if any) (Nota: Sila rujuk panduan tajuk tesis yang dilampirkan):

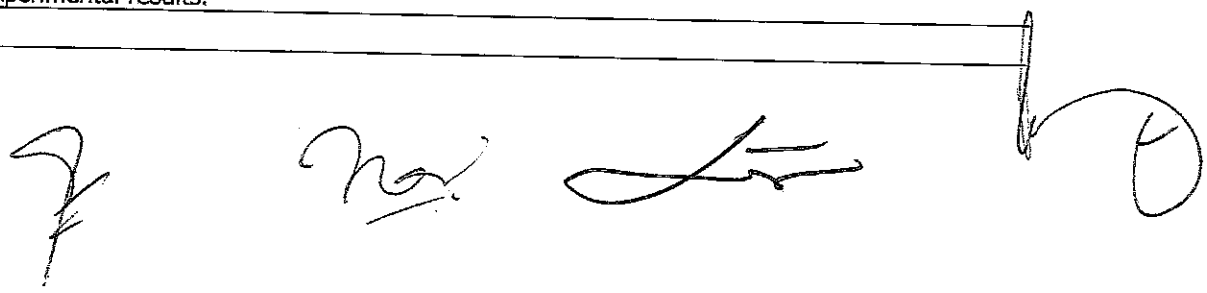
Simulation of Optical and Electronic Characteristics of Terahertz Quantum Cascade Laser

KOMEN (General Comments) :

The novelty of the thesis is that for a particular structure, the simulation can predict the gain spectrum of the broadband THz QCL.

In the thesis should clearly put the improved coding that has been done & the particular equation that is used. The limitation of the simulation must be declared.

The verification of simulation work must be done i.e. comparing the simulation result with the experimental work. Just compare the simulation result with the experimental result at the same current density applied as in experiment. There must be an additional equation/effect to be inserted in the coding so that it will produced the result that is similar with the experimental results.



Abstrak (Abstract)

Highlight the significant findings.

Bab 1 (Chapter 1)

The problem statement is not clear. It must be very specific - the lack of prediction on gain spectrum of broadband THz QCL. What is the limitation in the experimental work that can be explained by the simulation model/theory.

Each objective must be novel and written clearly. To improve the existing code on the prediction of broadband THz QCL to study its gain medium. Insert the reference of the code.

Declare the limitations/assumptions that has been considered in the modeling.

The scope of study is too brief. There is now flow of work.

Bab 2 (Chapter 2)

Literature review is too brief. Only 1.5 page. Should write more.

Pg 14-17 is copied from another PhD thesis – Benjamin from MIT 2003. Re-write all of it in own words.

Pg 17 – nothing is explained about optical gain though the title 2.3.1 is about optical gain.

Pg 17-19 Insert the reference of the equations.

Elaborate more on phonon resonance in 2.3.3.

Bab 3 (Chapter 3)

Summary of the improved part of the existing code should be explained in the chapter.

Pg 55 – do not use the word 'user'. Change to passive voice.

Pg 56 – explain why all the parameters (dielectric constant, size, doping, etc) are chosen.

Bab 4 (Chapter 4)

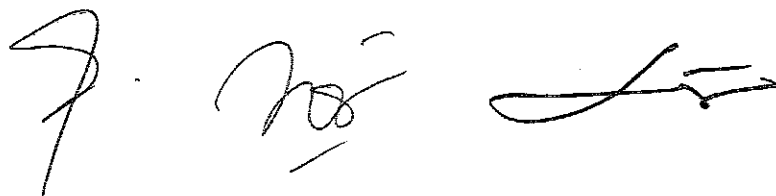
Define the broadband range. It must be consistent throughout the thesis.

Verification of the simulation work must be done.

Analysis of the results must be in depth. Give the reason why the results appear as it is. The significance of the result. Explain why and how it happened. Use the equations in Chapter 2 to support the arguments.

Pg 67 – Elaborate the name of each designs. Can be named base on the reference.

Pg 70 – Explain why current density J is used to plot the graph instead of current I . Put the experimental result together with the simulation result on the same graph.





Pg 73 – Elaborate more on the sentence 'mistakenly locked'.

Grammar error must be corrected.

Pg 84 – Section 4.4.5 the summary is too brief.

Mention the plots is refer to which equation.

Pg 100 – Explain why only TM mode is chosen for analysis. Otherwise must include the result for TE mode as well.

Re-write some of the subtitles (e.g. the subsection 4.6.3). It must be meaningful.

Put in the theoretical limit of the quantum efficiency if possible

Bab 5 (Chapter 5)

Highlight the findings and you have achieved the objectives

Bab 6 (Chapter 6) - Reference

The reference is not standard. It is not sequential.

The latest reference is 2014.

Bab 7 (Chapter 7)

Bab 8 (Chapter 8)

Bab 9 (Chapter 9)

J. N. S.

(C)

**IJAZAH DOKTOR FALSAPAH (DEGREE OF DOCTOR OF PHILOSOPHY)
LAPORAN PEMERIKSAAN TESIS – LUARAN (EXAMINER'S REPORT ON THESIS - EXTERNAL)**

Nama Calon : <u>Mohd Asmu'i bin Mohd Akil</u> (Name of Candidate)	Tajuk Tesis : <u>Modelling of Optical and Electronic Characteristics for Broadband Aluminium Gallium Arsenide Terahertz Quantum Cascade Laser</u> (Title of Thesis)
Fakulti : <u>Faculty of Science</u> (Faculty)	
Nama Pemeriksa dan Institusi : <u>Prof Dr Mohd Kamil Abd Rahman</u> (Name of Examiner and Institution)	<u>Faculty of Applied Sciences,</u> <u>University Teknologi MARA</u> <u>40450 Shah Alam, Selangor</u>

SILA TANDATANGAN DI DALAM RUANG YANG DISEDIAKAN UNTUK PERAKUAN
(Please initial in space provided for the recommendation)

TANDATANGAN
(INITIAL)

1. Perakuan (Recommendation)

Setelah memeriksa tesis, saya perakuan (After examining the thesis, I recommend that)

- a) Calon dianugerahkan ijazah Doktor Falsafah (The candidate be awarded the degree of Doctor of Philosophy);.....
- atau (or) b1) Calon dianugerahkan ijazah Doktor Falsafah setelah membuat pembetulan kecil (The candidate be awarded the degree of Doctor of Philosophy (PhD) subject to minor corrections);.....
- atau (or) b2) Calon dianugerahkan ijazah Doktor Falsafah (PhD) setelah membuat pindaan dan pembetulan kepada tesis seperti yang disenaraikan dalam laporan ini dan disahkan telah berbuat demikian oleh Pemeriksa Dalam/Luar berkenaan; (The candidate be awarded the degree of Doctor of Philosophy (PhD) subject to the amendments and corrections as listed elsewhere in this report being made in the thesis to the satisfaction of the Internal/External Examiner(s));.....
- atau (or) c) Calon tidak dianugerahkan ijazah Doktor Falsafah (PhD) tetapi dibenarkan menghantar semula tesis untuk pemeriksaan setelah menjalani kajian dan penyelidikan lanjutan. (The candidate not be awarded the degree of Doctor of Philosophy (PhD) but be permitted to resubmit the thesis for further examination in a revised form after a further period of study and research);.....
- atau (or) d) Pencapaian calon tidak memuaskan untuk ijazah Doktor Falsafah (PhD) tetapi dicadangkan satu ijazah yang lebih rendah. (The candidate not be awarded the degree of Doctor of Philosophy (PhD) but a lower degree);.....
- atau (or) e) Calon tidak dianugerahkan ijazah Doktor Falsafah (PhD). (The candidate not be awarded the degree of Doctor of Philosophy (PhD))

2. Pendapat (Opinion)

Saya berpendapat (In my opinion)

- a) Tesis ini mengandungi banyak sumbangan asli ke arah pembangunan ilmu dalam bidang berkenaan (The thesis has substantial original contribution to the knowledge of the subject concerned);.....
- b) Keaslian tesis dibuktikan dengan penemuan fakta-fakta baru (The thesis affords evidence of originality by the discovery of new facts);.....
- c) Keaslian tesis dibuktikan dengan kebolehan memberi kritikan yang bernas dan jelas (The thesis affords evidence of originality by exercising of independent critical ability).....
- d) Tesis ini memuaskan dari segi penyampaian (The thesis is satisfactory in regards to literary presentation);.....
- e) Terdapat hasil kajian dalam tesis sesuai untuk diterbitkan (A significant amount of findings in the thesis are worthy of publication);.....

3. Merit(Merit)

Dalam membuat perakuan di atas, saya sahkan calon adalah cemerlang untuk ijazah ini dan dianugerahkan ijazah dengan merit. (In making the above recommendation, I consider that the candidate is outstanding for this degree and should be awarded the degree with merit).....

Tandatangan (Signature):

Tarikh (Date): 18 Apr 2017.....

4. Sila berikan ulasan terhadap perkara berikut untuk dijadikan asas perakuan (*Please comment on the following aspects as the grounds for recommendation*)

4.1 Tajuk Tesis (*Title of the Thesis*)

AlGaAs is **NOT written** anywhere in the Abstract and sections on Introduction, Background of Problem, Statement of Problem, and Research Objectives in Chapter 1.

Then, what is the significant of writing AlGaAs in the title?

Do not need to spell in full for *AlGaAs* in the title (only if it is significant to have "AlGaAs" in the tile.)

The work is based on AlGaAs/GaAs, why GaAs is not stated in the title or any part of Chapter 1? Gain medium is one of the important components of any lasers.

4.2 Abstrak (*Abstract*)

There is NO clear scientific or technical **Statement of Research Problems** in the Abstract.

Since there is NO Research Problem stated clearly in the Abstract, then there is no particular approach of solving the research problems. Thus, the methodology and results obtained are not focused to gain any significant findings.

Novelty or significant findings on something new in the research work could not be found.

4.3 Kajian Literatur (*Literature Review*)

Thesis reports about modeling of QCL, but none of the references in Table 2.1 has any work done on modeling the laser. Must cite more references on modeling QCL and discuss them thoroughly.

Section 2.2 (Previous Works on Designing QCL structures) is insufficient and unacceptable. (less than 1½ page).

Section 2.3 (pg. 14) – **PLAGIARISM in the thesis, where word-by-word of every page from page 14 to 17 (4 pages)** from the work of Benjamin S. Williams, M.I.T. 2003 PhD Thesis "Terahertz Quantum Cascade Lasers".

Plagiarism is totally unacceptable because it is an academic offense and unethical in academic society. Plagiarism should never be allowed to be in any part of academic activities, especially not in any PhD thesis.

The thesis of Benjamin is not in the list of references. This thesis should be given a "fail".

Section 2.3.1 (Intersubband and **Optical Gain**): Nothing about **Optical Gain** is mentioned or explained in the text.

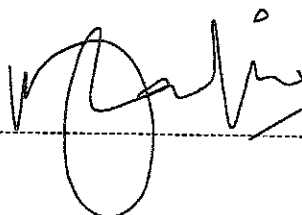
Literature Review takes about less than 10% (4½ page from 43 pages), while the rest of the Chapter is on background theory on QCL with large number of mathematical equations and techniques on modeling.

Literature Review is insufficient; lack of depth and width, hence cannot be accepted.

Any equations that are not relevant or not used in the modelling must be taken out of the thesis. Only those mathematical equations used in modelling QCL and metal waveguide should be in the thesis.

It is better to have another Chapter on "Theory and Modelling of QCL", while Literature Review has a chapter on its own.

Tandatangan (*Signature*):



Tarikh (*Date*): 18 Apr 2017

4.4 Methodologi (Methodology)

Section 3.2: Algorithm on the computer modelling program is not clear with poor use of English. Laser structure designs of QCL for the modelling must be shown. Source code program (**claimed to be newly improved**) for modelling QCL must be included in the thesis (in Appendix). The newly improved code has not been written anywhere in Methodology and its **improved codes could not be evaluated**.

The I-V characteristics and gain spectra that were modeled are based on four QCL designs from 3 cited references. The candidate **did not design any new or novel structure of THz QCL for modelling** to improve previous designs.

There is **no continuation and flow of study** from previous work above and on the modelling of optical modes in double metal QCL waveguide. This double metal QCL waveguide only has GaAs as its gain medium, while previous work was on AlGaAs/GaAs materials were used in the model.

The double metal QCL **waveguide design is adapted from 2 published works** by other researchers (Turcinkova and Markus Rosch).

There is **no new or novel design on double metal QCL waveguide constructed or modelled**.

4.5 Analisis (Analysis)

The thesis lacks depth in analysis on the results obtained. The thesis tends to present the results more of a reporting manner.

Critical analysis in discussing the results is very important element in providing significant contribution to a PhD thesis.

4.6 Keputusan dan Perbincangan (Results and Discussions)

The I-V curves from modelling of the four designs of QCL **do not match with I-V curves** of the experimental results from the 3 cited journals.

Thus, it is obvious that the **modelling fails to model** the THz QCL and the **candidate cannot claim** that the modelling of "I-V curves are in good agreement with the experimental results" as stated in the Conclusion.

The newly improved code fails to model and showed no improvement.

A full paragraph (11 lines) on page 67 was copied and paste with almost the exact sentences to pages 72, 76 and 80.

The candidate seems to have very poor ability on discussing and analyzing the results obtained; and has the bad habit of copy-and-paste style of writing.

In Methodology, it is stated that QCL will be modelled across a range on frequency from 1 – 10 THz, but none of the results presented are within this range. The results mostly presented with frequency range less than 10 THz.

Results plotted from the modeling should be referred-back to the mathematical equations in Chapter 2 to reflect all the parameters used in the model. Since there are quite a large number equations written in the Chapter 2 but to which equations are used for the model is not clearly stated.

How is the "Losses" in QCL relates to the optical gain of the laser?

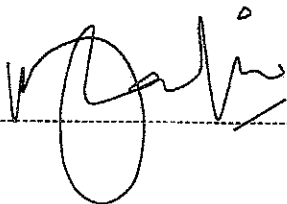
The "Losses" are below 30 cm^{-1} for the range of 2 – 3.5 THz; but the optical gains have values from $80 - 170 \text{ cm}^{-1}$.

We all know that lasing occurs only when gain is equal or more than the losses in the laser cavity.

Why can't the modelling of "loss and gain" employs the same QCL structure designs, so that they can be compared?

Why bother modeling double metal QCL waveguide if there is no continuation of flow in the study? These two structures are quite different.

Tandatangan (Signature):



Tarikh (Date): 18 Apr 2017

4.7 Kekuatan Tesis (*Strength of the thesis*)

The strength of the thesis could probably be in the background study on the theory of THz QCL and techniques in modelling.

4.8 Kelemahan Tesis (*Weakness of the thesis*)

1. Plagiarism on 4 pages of the thesis.
2. Lacking in critical analysis.
4. Modelling of I-V curves do not match the experimental results. The model failed.
5. Source code is not included in the thesis. Candidate claims to be a newly-improved programing codes, but these codes could not be evaluated and verified.
6. No new significant finding or novelty can be found in the thesis.
7. Insufficient content of Literature Review in terms of depth and width of Review.

4.9 Kepentingan Kajian (*Significance of the study*)

The study on THz QCL is of significant importance to the area of interest, to the country and to the global community.

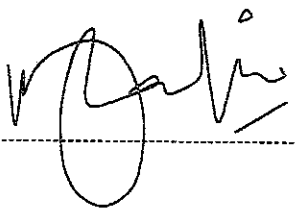
4.10 Perakuan penganugerahan (*Recommendation for the award*)

The candidate not to be awarded the degree of Doctor of Philosophy (PhD), but awarded a lower degree subjected to major corrections of the thesis and the thesis will be free from any form of plagiarism.

4.11 Lain-lain ulasan (*Other comments*)

These are the notable reasons for not awarding the candidate a PhD degree:

1. Plagiarism.
2. No significant findings / novelty, whereby does not contribute to any new knowledge.
3. All four (4) I-V curves that were modeled failed to match with the experimental I-V curves from 4 different QCL designs.
The failure of I-V modeling has created doubt to other results obtained from the modeling, however these other results could not be verified either to be correct or otherwise.
4. Thesis lacks critical analysis in discussing the results.
5. No new/novel THz QCL structural designs and metal QCL waveguide were proposed by the candidate. All designs are taken from other researchers' work, which were dated in 2009 and 2012.

Tandatangan (*Signature*):  Tarikh (*Date*): 18 Apr 2017

UNIVERSITI TEKNOLOGI MALAYSIA

**IJAZAH DOKTOR FALSAFAH (DEGREE OF DOCTOR OF PHILOSOPHY)
LAPORAN PEMERIKSAAN TESIS (EXAMINER'S REPORT ON THESIS)**

Nama Calon <i>(Name of Candidate)</i>	<u>Mohd Asmu'i Bin Mohd Akil</u>	Tajuk Tesis <i>(Title of Thesis)</i>	<u>Modelling of Optical and Electronic Characteristics for Broadband Aluminum Gallium Arsenide Terahertz Quantum Cascade Laser.</u>
Fakulti <i>(Faculty)</i>	<u>Fakulti Sains</u>		
Nama Pemeriksa dan Institusi <i>(Name of Examiner and Institution)</i>	<u>Prof Madya Dr. Yusof Bin Munajat</u> <u>Fakulti Sains,</u> <u>UTM, Johor Baharu.</u>		

SILA TANDATANGAN DI DALAM RUANG YANG DISEDIAKAN UNTUK PERAKUAN
(Please initial in space provided for the recommendation)

TANDATANGAN

(INITIAL)

1. Perakuan (Recommendation)

Setelah memeriksa tesis, saya perakuan *(After examining the thesis, I recommend that)*

a) Calon dianugerahkan ijazah Doktor Falsafah *(The candidate be awarded the degree of Doctor of Philosophy);*.....

atau (or) b1) Calon dianugerahkan ijazah Doktor Falsafah setelah membuat pembetulan kecil *(The candidate be awarded the degree of Doctor of Philosophy subject to minor corrections);*.....

atau (or) b2) Calon dianugerahkan ijazah Doktor Falsafah setelah membuat pindaan dan pembetulan kepada tesis seperti yang disenaraikan dalam laporan ini dan disahkan telah berbuat demikian oleh Pemeriksa Dalam/Luar berkenaan; *(The candidate be awarded the degree of Doctor of Philosophy subject to the amendments and corrections as listed elsewhere in this report being made in the thesis to the satisfaction of the Internal/External Examiner(s));*.....

atau (or) c) Calon tidak dianugerahkan ijazah Doktor Falsafah tetapi dibenarkan menghantar semula tesis untuk pemeriksaan setelah menjalani kajian dan penyelidikan lanjutan. *(The candidate not be awarded the degree of Doctor of Philosophy but be permitted to resubmit the thesis for further examination in a revised form after a further period of study and research);*.....



atau (or) d) Pencapaian calon tidak memuaskan untuk ijazah Doktor Falsafah tetapi dicadangkan satu ijazah yang lebih rendah. *(The candidate not be awarded the degree of Doctor of Philosophy but a lower);*

atau (or) e) Calon tidak dianugerahkan ijazah Doktor Falsafah. *(The candidate not be awarded the degree of Doctor of Philosophy);*.....

2. Pendapat (Opinion)

Saya berpendapat *(In my opinion)*

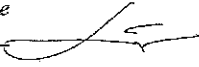
a) Tesis ini mengandungi banyak sumbangan asli ke arah pembangunan ilmu dalam bidang berkenaan *(The thesis has substantial original contribution to the knowledge of the subject concerned);*.....

b) Keaslian tesis dibuktikan dengan penemuan fakta-fakta baru *(The thesis affords evidence of originality by the discovery of new facts);* _____

c) Keaslian tesis dibuktikan dengan kebolehan memberi kritikan yang bernas dan jelas *(The thesis affords evidence of originality by exercising of independent critical ability)* _____

d) Tesis ini memuaskan dari segi penyampaian (*The thesis is satisfactory in regards to literary presentation;*) _____

e) Terdapat hasil kajian dalam tesis sesuai untuk diterbitkan (*A significant amount of findings in the thesis are worthy of publication;*) _____

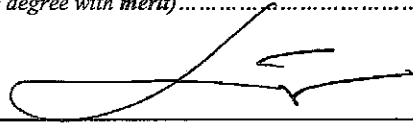


3.

Merit(Merit)

Dalam membuat perakuan di atas, saya sahkan calon adalah cemerlang untuk ijazah ini dan dianugerahkan ijazah dengan **merit**. (*In making the above recommendation, I consider that the candidate is outstanding for this degree and should be awarded the degree with merit*).....

Tandatangan (*Signature*):



Tarikh (*Date*): 12/6/2017 _____

4. Sila berikan ulasan terhadap perkara berikut untuk dijadikan asas perakuan (*Please comment on the following aspects as the grounds for recommendation*)

4.1 Tajuk Tesis (*Title of the Thesis*)

Title of the thesis is not suitable since the title is not fully reflects the objectives. The title and objectives need to be rewrite in order cover the content of study. The title should more specific and highlights the contribution of study.

4.2 Abstrak (*Abstract*)

The abstract is satisfactory and written describing the studies. However the content of study needs to be revised because not fully cover the important part of thesis. The final outcome must be highlighting the contribution of studies.

4.3 Kajian Literature (*Literature review*)

The candidate prepares literature review on various topics; however it is not directly relevant to the study. Since the study based on the modelling, candidate should review previous conducted methods and highlight the new approach. The literature must be properly cited and really used in the studies. The related Equation must be quote clearly.

Tandatangan (*Signature*):



Tarikh (*Date*): 12/6/2017

4.4 Methodologi (*Methodology*)

Research methodology is not well structured and the aim of study is blurring. The description of methodology is not clear and not detailed. Research methodology must have research activities that related to the objectives. The result should answer the objectives. The objectives then reflect the title.

The studies is based on the modelling and said to improve the coding, but no appendix to show the coding or programming of the studies. The equations used in the studies also not all quote properly.

The studies should focus on one design model and highlight the new improvement that has been done as your contribution. The optical modes for broadband waveguide also need clear description to relate with your first study.

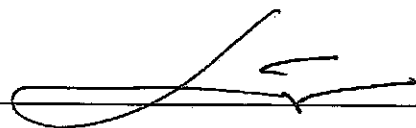
4.5 Analisis (*Analysis*)

This study based on modelling of THz Quantum Cascade laser. First using Density Matrix Method study the individual active region of THz QCL by comparing with experimental work. Second using Finite Element Method study the ability of optical mode for broad range emission.

The analysis shows the bias in THz QCL, the energy of levels versus electric field, the evolution population densities by bias changes and I-V curves from previous researcher Kumar. Then the analysis expended to other researcher of THz QCL.

Based on the analysis, most of the results just plot the graph of previous researcher experiment data and the calculation done by candidate. I can't see extra information that is impossible to measure experimentally. The modelling should show much better and high performance of THz QCL based to some new assumption and approach can be engineered that can expect improvement result.

Tandatangan (*Signature*):



Tarikh (*Date*): 12/6/2017

4.6 Keputusan dan perbincangan (*Results and discussions*)

According to the results obtained,

- a. The modelling results and discussion digested and compared with previous researcher.
- b. Schematic diagram shown almost well presented, but the graph of I-V not represents the good practice of plotting.
- c. Candidate not able to developed new assumption and approach that can improve the THz output.

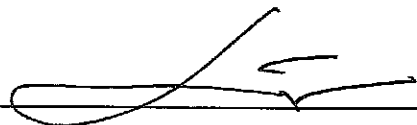
4.7 Kekuatan Tesis (*Strength of the thesis*)

4.8 Kelemahan Tesis (*Weakness of the thesis*)

Most of the weakness of the thesis as follows;

1. The title not really represent to the objectives.
2. The objectives must be from good Research Problem.
3. Every objective must follow the related research activities.
4. The literature review must be from the most relevance cited reference.
5. Research methodology description must be clear based on detail research activities.
6. The equations used in the programming must be quote precisely.
7. The results should answer the research problems.
8. The study based on the modelling and the new coding or programming should put in the appendix.
9. The graph of I-V not represents the good practice plotting of graph.
10. The final result is the THz output, but how your new assumption and approach can improve the output.

Tandatangan (*Signature*):



Tarikh (*Date*): 12/6/2017

4.9 Kepentingan Kajian (*Significance of the study*)

The study "Modelling of Optical and Electronic Characteristics for Broadband Aluminum Gallium Arsenide Terahertz Quantum Cascade Laser", implies the importance application of the THz spectroscopy and imaging. It can contribute to the development of THz Quantum Cascade Laser and human capital in this field. Hopefully it is used as the catalyst and reference point for further research.

4.10 Perakuan pengamugrahan (*Recommendation for the award*)

I hereby certify that the candidate not be awarded the degree of Doctor of Philosophy but be permitted to resubmit the thesis for further examination in a revised form after a further period of study and research.

I would like to reserve my final decision till the viva presentation.

4.11 Lain-lain ulasan (*Other comments*)

Refer to the thesis.

Tandatangan (*Signature*):



Tarikh (*Date*): 12/6/2017

UNIVERSITI TEKNOLOGI MALAYSIA

IJAZAH DOKTOR FALSAFAH (DEGREE OF DOCTOR OF PHILOSOPHY)
LAPORAN PEMERIKSAAN SEMULA TESIS (REPORT ON THESIS REEXAMINATION)**RESUBMISSION**

Nama Calon : Mohd Asmu'i bin Mohd Akil
(Name of Candidate)

Fakulti : Faculty of Science
(Faculty)

Tajuk Tesis : Simulation of Optical and Electronic Characteristics of Terahertz Quantum Cascade Laser
(Title of Thesis)

Nama Pemeriksa dan Institusi : Prof. Dr. Mohd Kamil Abd. Rahman
(Name of Examiner and Institution) School of Physics and Material Studies,
Faculty of Applied Sciences,
University Teknologi MARA,
40450 Shah Alam,
Selangor

Tarikh Viva : 21/06/2017
(Date of Viva)

Keputusan Viva : C1
(Viva's Result)

SILA TANDATANGAN DI DALAM RUANG YANG DISEDIAKAN UNTUK PERAKUAN
(Please initial in space provided for the recommendation)TANDATANGAN
(INITIAL)

1. **Perakuan (Recommendation)**
Setelah memeriksa tesis, saya perakuan (After examining the thesis, I recommend that)

LULUS/PASS

- (a) Pelajar telah membuat pembedulan sepertimana yang tercatat dalam laporan pengurusan peperiksaan lisan. Pelajar dianugerahkan Ijazah Kedoktoran. (The candidate has done all the necessary amendments and corrections and be awarded the degree of Doctor of Philosophy)

atau (or)

- (b1) Pelajar telah membuat pembedulan namun terdapat sedikit lagi pembedulan yang perlu dibuat. Pelajar dianugerahkan Ijazah Kedoktoran selepas pembedulan dan hanya perlu disahkan oleh penyelia. (The candidate be awarded the degree of Doctor of Philosophy subject to minor corrections as listed elsewhere in this report being made in the thesis to the satisfaction of the Supervisor)

atau (or)

- (b2) Pelajar telah membuat pembedulan namun terdapat lagi pembedulan yang perlu dibuat. Pelajar dianugerahkan Ijazah Kedoktoran selepas pembedulan dan disahkan telah berbuat demikian oleh Pemeriksa Dalam/Luar. (The candidate be awarded the degree of Doctor of Philosophy subject to corrections as listed elsewhere in this report being made in the thesis to the satisfaction of the Internal/External Examiner(s))

atau (or)

IJAZAH LEBIH RENDAH/LOWER DEGREE

- (d) Pencapaian calon tidak memuaskan untuk ijazah Doktor Falsafah tetapi dicadangkan satu ijazah yang lebih rendah. (The candidate not be awarded the degree of Doctor of Philosophy but a lower)

atau (or)

GAGAL/FAIL

- (e) Pelajar gagal membuat pembedulan yang ditetapkan dalam peperiksaan lisan pertama. Oleh itu pelajar tidak dianugerahkan Ijazah Kedoktoran. (The candidate not be awarded the degree of Doctor of Philosophy)

Tandatangan (Signature): 

Tarikh (Date): ...22 Jan 2019.....

2. Sila berikan ulasan terhadap perkara berikut untuk dijadikan asas perakuan (*Please comment on the following aspects as the grounds for recommendation*)

2.1 Tajuk Tesis (*Title of the Thesis*)

Acceptable

2.2 Abstrak (*Abstract*)

1. Problem statement is not clear and not specific, especially the sentence “..... undermine its suitability to meet current industrial expectations.” What exactly is the current industrial expectation this issue is addressing? The problem statement has to be specific ... is it in terms of *power?* *bandwidth?* or something else?
Thus, state exactly the current status of the problem and the specific expectation required by the industries.
2. The **research Findings** are not clearly stated. The research findings must reflect-back into solving the research problems (above ϕ) and not something else.
 - State clearly what are the **research findings** – these were **derived** from the results obtained?
 - Do not to show all the results obtained from the research, just show the significant results and followed by the research findings – anyone who reads the findings will gain benefit from it.
 - From the research outputs, state clearly **what are the main factors that limit QCL performance** for future designs of QCL.

2.3 Pengenalan, Masalah Penyelidikan, Objective, Skop dll (*Introduction, Research Problems, Objectives, Scope etc*)

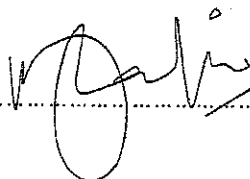
Research Problems are not specific, and not clear.

Rewrite the Research Problems: - state clearly and SPECIFICALLY what are the current problems with QCL (output power, bandwidth, others), structural designs, etc. The Problem Statement should be based on **facts** (based on theory and published work), and not some assumptions.

- It has to be **scientific or technical problem/s**.
- It is a widely known fact that simulation or modeling of a device can save the cost of fabricating and testing of the device. So please do not use this reason as the problem statement. It is **not a research problem**.

Rewrite the Research Objectives based on the research problems – that is finding ways to solve the problems.

Tandatangan (*Signature*):



Tarikh (*Date*): 22 Jan 2019.....

2.4 Kajian Literatur (*Literature Review*)

This thesis does not show to have much improvement on Literature Review as compared to the Thesis previously written, where comments and suggestions were made in the thesis and during viva examination so as to improve on this chapter.

Thesis reports the simulation of QCL, but none of the references in Table 2.1 has any work done in simulating QCL. Must cite 1 or 2 references on QCL simulation and make critical review of them. Example: from E. Bellotti et al. (2008 and 2009) and others.

Section 2.2 (Previous Works on QCL structures) is insufficient **and again, it is unacceptable.** (about 1½ page long). It is NOT much of a Literature Review, but more of Literature Survey (**Reporting the summary of other researchers' work**). It must be a **Critical Review** where every comment/summary of each cited reference must be linked to each others' works, while giving your own opinions, ideas and suggestions.

Section 2.3 of page 15 was rewritten where the content of this Section was PLAGIARISED (previous thesis) from the work of Benjamin S. Williams, M.I.T. 2003 PhD Thesis "Terahertz Quantum Cascade Lasers".

The whole of section (2.3) was rewritten based on Benjamin's thesis; **HOWEVER, Benjamin S. Williams was NOT cited in the list of References.** Extorting the work from others while not giving appropriate acknowledgement and recognition is unethical.

Literature Review takes about less than 9% (5 pages from 56 pages), while the rest of the Chapter is background theory on QCL with large number of mathematical equations and techniques on simulation.

Literature Review is insufficient; lack of depth and width, hence is not accepted, **again!**

This thesis needs to have a separate Chapter on "Theory and Simulation/Modeling of QCL", while Literature Review can have a chapter on its own.

2.5 Methodologi (*Methodology*)

Section 3.2: The section of the modified code is given in Appendix B.2. However, there no statement stating clearly what was modified from the original program code. This is rather important because this modification will be the evident as original contribution to new knowledge. Thus, it must be specified clearly.

The simulation is based on Equation (2.63) where it was expanded to Equations (2.64) and (2.65). **HOWEVER**, there are "errors" in these 2 equations. Please make the corrections.

Give evidences or proofs from previous work **or from this work**, that the 15% of aluminium in the barrier layers that was ignored/neglected does not have any effect on the simulation outputs. The actual structures have 15% aluminium in the barrier layers, where 15% is not a small amount. Probably it would be better to show both of the results, one with and one without the aluminium to prove the assumption.

The schematic diagram of QCL in Figure 3.3 is **NOT CORRECT**. If the quantum layers were to be grown in the z-direction, then the electric current flowing through the top and bottom Au contact layers will be short-circuited and burn the laser. See Figure C.1, where this is how structure should be drawn.

Redraw the QCL structure as Figure 3.3, showing clearly *x-y-z* axes, active-layers, Au contact-layers, waveguide with mirror facets and dimensions for its width, thickness and cavity length.

Apparently, there is no new or novel design of QCL structure or double metal QCL waveguide was proposed or simulated in thesis.

- Draw an overall flowchart showing the process flow how all the objectives can be achieved and research outcomes have solved the research problems.

Tandatangan (*Signature*):

Tarikh (*Date*): 22 Jan 2019

2.6 Analisis (*Analysis*)

- Results were discussed but the analyses are insufficient. Many important phenomena were not clearly explained.

- A few phrases/paragraphs were repeated copied, exactly the same phrases for all the 4 QCL designs, see paragraphs on page 72, 76, 80, 81, 84, and 85.

- The habit of copy and paste shows lacking in the ability to analyse results.

- There is also insufficient analysis on the Gain Spectra. In-depth discussion on gain spectra is very important because it is fundamental to support the principle behind in achieving broad bandwidth – this is one of the research objectives. The reason given for simulation only in the TM modes in metal waveguides is unacceptable. A 30- μm width is NOT significantly larger than to the height of a 13- μm waveguide (height is more than 1/3 of the width) and the width cannot be assumed infinite. A 13- μm waveguide should be sufficient to support TE modes, unless the simulation for TE modes proved otherwise.

It is rather known facts that refractive index increased with frequency in most dielectric and semicond materials and optical confinement is better for larger (40- μm) waveguides. The simulations results from these two phenomena are obvious and not new, thus they are not significant to the study.

Insufficient analysis of plasmonic effect on the optical confinement in the waveguide. It seems that high optical confinement is based on dielectric properties and not plasmonic effect at THz frequencies (see 1st paragraph page 109). However, the discussion on page 111 explained otherwise. The summary has to be very clear of the final findings from the simulations and explanations should complement and support one another.

2.7 Keputusan dan Perbincangan (*Results and Discussions*)

Part #1: The DM program code has been verified from experimental results of Kumar [2], based on Equation (2.63). Make correction to errors in Equations (2.64) and (2.65).

- Show and explain exactly how anticrossing values were taken from Fig. 4.3.

Part #2: Following verification of DM program codes, 4 other QCL designs were simulated the same (see page 71 to 88). The **Summary** of the results is repeating what were previously discussed. There is **nothing significant in the summary** that can be of benefit to support next stage of the study, due to insufficient analysis.

What is most important in the Summary is the research findings: what NEW parameter settings, limitations, electronic transport mechanism properties that could help widen the width of the spectrum as suggested in Objective (2) and (3). To what level of Objectives 2 and 3 had been achieved?

Part #3: Here again, there is **no analysis** on the discussion of **Gain Spectra** for all the 4 QCL designs. All explanations are of a **Reporting style** – where it just report what were displayed in the plots, BUT there is **NO EXPLANATION** given to what cause it to behave the way it is and why:

1. There a shift in the spectral peak gain as voltage varies?
2. Broadening of spectra as voltage varies?
3. Disappearing of gain spectra when stimulated emission was included?
4. WHAT parameter/s influence and determine the width of gain spectra?
5. HOW can the spectral width be controlled or manipulated?

These questions do not have any answer, because there was no analysis done on the Gain Spectra to relate to the physical properties and structural design of all the 4 QCL.

Parts #1, #2 and #3 covers 34 pages from page 67 to 101 (30% of the thesis), but unfortunately these 3 Parts did not contribute towards the novelty of the study or contribution to new knowledge, because they lack detail analyses.

It has been proven that Double Metal Waveguide QCL demonstrates high optical mode confinement but here in the thesis, it does not have any suggestion to further improved it.

Tandatangan (*Signature*):

Tarikh (*Date*): 22 Jan 2019

2.8 Kekuatan Tesis (*Strength of the thesis*)

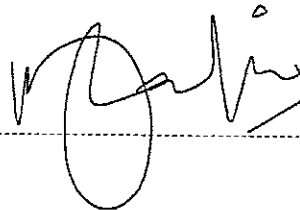
The strength of the thesis could probably be in the background study on the theory of THz QCL and techniques in simulation.

2.9 Kelemahan Tesis (*Weakness of the thesis*)

1. No new design of QCL were proposed and simulated. All simulations were based on previous QCL design by others.
2. Significantly lacking in critical analysis in all discussion of results.
3. DM Program Code claimed be modified from original work, but what exactly were modified is not mentioned. Hence, novelty or contribution to new knowledge is questionable.
4. No new significant finding or novelty can be found in the thesis.
5. Insufficient content of Literature Review in terms of depth and width of Review.

2.10 Kepentingan Kajian (*Significance of the study*)

The study on THz QCL is of significant importance to the area of interest, to the country and to the global community.

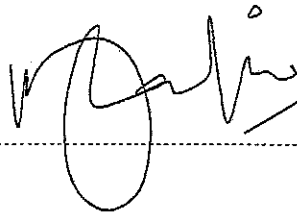
Tandatangan (*Signature*):Tarikh (*Date*): 22 Jan 2019

3.0 Perakuan penganugerahan (*Recommendation for the award*)

The candidate awarded the degree of Doctor of Philosophy (PhD) subject to all corrections being made as listed in the examiners report, viva panel report and elsewhere in the thesis to the satisfaction of the Examiners.

5.1 Lain-lain ulasan (*Other comments*)

1. All sections of discussion must have detail analysis of the results – simply by answering: HOW and WHAT cause it to happen and WHY it occurs that way? Without any analysis, it is similar to a **REPORT** of a study - and **NOT** a **THESIS**.
2. Highlight the novelty of the study – difficult to identify it in the thesis.
All QCL designs are taken from other researchers' work, dated in 2009 and 2012, where no new design was proposed to improve QCL performance.

Tandatangan (*Signature*):Tarikh (*Date*): 22 Jan 2019

RESUBMISSION**IJAZAH DOKTOR FALSAFAH (DEGREE OF DOCTOR OF PHILOSOPHY)
LAPORAN PEMERIKSAAN TESIS (EXAMINER'S REPORT ON THESIS)**Nama Calon : Mohd Asmu'i Bin Mohd Akil
(Name of Candidate)Tajuk Tesis :: Simulation of Optical and Electronic
(Title of Thesis) Characteristics of Terahertz Quantum
Cascade Laser.Fakulti : Fakulti Sains
(Faculty)Nama Pemeriksa dan Institusi : Prof Madya Dr. Yusof Bin Munajat
(Name of Examiner and Institution) Fakulti Sains,
UTM, Johor Baharu.SILA TANDATANGAN DI DALAM RUANG YANG DISEDIAKAN UNTUK PERAKUAN
(Please initial in space provided for the recommendation)

TANDATANGAN

(INITIAL)

1. **Perakuan (Recommendation)**

Setelah memeriksa tesis, saya perakuan (After examining the thesis, I recommend that)

- a) Calon dianugerahkan ijazah Doktor Falsafah (The candidate be awarded the degree of Doctor of Philosophy);.....
- atau (or) b1) Calon dianugerahkan ijazah Doktor Falsafah setelah membuat pembetulan kecil (The candidate be awarded the degree of Doctor of Philosophy subject to minor corrections);.....
- atau (or) b2) Calon dianugerahkan ijazah Doktor Falsafah setelah membuat pindaan dan pembetulan kepada tesis seperti yang disenaraikan dalam laporan ini dan disahkan telah berbuat demikian oleh Pemeriksa Dalam/Luar berkenaan; (The candidate be awarded the degree of Doctor of Philosophy subject to the amendments and corrections as listed elsewhere in this report being made in the thesis to the satisfaction of the Internal/External Examiner(s));.....
- atau (or) c) Calon tidak dianugerahkan ijazah Doktor Falsafah tetapi dibenarkan menghantar semula tesis untuk pemeriksaan setelah menjalani kajian dan penyelidikan lanjutan. (The candidate not be awarded the degree of Doctor of Philosophy but be permitted to resubmit the thesis for further examination in a revised form after a further period of study and research);.....
- atau (or) d) Pencapaian calon tidak memuaskan untuk ijazah Doktor Falsafah tetapi dicadangkan satu ijazah yang lebih rendah. (The candidate not be awarded the degree of Doctor of Philosophy but a lower);
- atau (or) e) Calon tidak dianugerahkan ijazah Doktor Falsafah. (The candidate not be awarded the degree of Doctor of Philosophy).....

2. **Pendapat (Opinion)**

Saya berpendapat (In my opinion)

- a) Tesis ini mengandungi banyak sumbangan asli ke arah pembangunan ilmu dalam bidang berkenaan (The thesis has substantial original contribution to the knowledge of the subject concerned);.....
- b) Keaslian tesis dibuktikan dengan penemuan fakta-fakta baru (The thesis affords evidence of originality by the discovery of new facts);
- c) Keaslian tesis dibuktikan dengan kebolehan memberi kritikan yang bernas dan jelas (The thesis affords evidence of originality by exercising of independent critical ability)
- d) Tesis ini memuaskan dari segi penyampaian (The thesis is satisfactory in regards to literary presentation;).....
- e) Terdapat hasil kajian dalam tesis sesuai untuk diterbitkan (A significant amount of findings in the thesis are worthy of publication;)

3. **Merit (Merit)**Dalam membuat perakuan di atas, saya sahkan calon adalah cemerlang untuk ijazah ini dan dianugerahkan ijazah dengan **merit**. (In making the above recommendation, I consider that the candidate is outstanding for this degree and should be awarded the degree with **merit**).....

Tandatangan (Signature): Tarikh (Date): 24/12/2018.....

4. Sila berikan ulasan terhadap perkara berikut untuk dijadikan asas perakuan (*Please comment on the following aspects as the grounds for recommendation*)

4.1 Tajuk Tesis (*Title of the Thesis*)

The title has been changed according to the suggestion; Simulation of optical and electronic characteristics of terahertz quantum cascade laser.

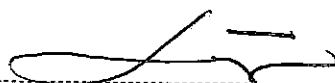
4.2 Abstrak (*Abstract*)

The abstract was rewritten and highlight the significant finding by theoretically analyzing the broadband design of Tera Hertz Quantum Cascade Laser (QCL).

4.3 Kajian Literature (*Literature review*)

The candidate prepares literature review on various topics. Still have some issues that not address carefully. Figure 2.1(a) and (b) still not explained in details. Rate equation still there and not removed from the text. Since the study based on the modelling, previous conducted methods must be properly reviewed and new approach of equations used in the studies must be highlight clearly.

Tandatangan (*Signature*):



Tarikh (*Date*): 24/12/2018

4.4 Methodologi (Methodology)

The studies based on the modelling and claim in predicting the performance of broadband THz QCL. There are two major work involved. Firstly, the simulation of electron transport in the active region of THz QCL. The code was improved by modifying the code to solve the numerical quantum transport in a four level THz QCL system. Secondly, the numerical study of narrow waveguide THz QCL to support the broadband emission, extensively the optical mode with the addition of narrow waveguide effect of the devices. The coding is shown in the appendix B and C.

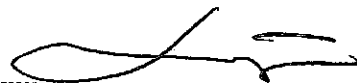
However still have some issues that not address carefully in this Methodology. In the flow chart Figure 3.1 the modification part must be clearly highlight. The details explanation must be highlight at the end of subtopic 3.2 to support the strength of the thesis. The same thing must be highlight the modification in Figure 3.2 and the explanation at the end of subtopic 3.3.

4.5 Analisis (Analysis)

No significant improvement of the study based on the modification done to the existence equations. Based on the analysis, most of the results just plot the graph of previous researcher experiment data and the simulation calculation done by candidate using the existence equations. The modelling should show much better and high performance of THz QCL based on some new assumption and approach can be engineered that can expect improvement result.

Candidate make a comparison for different design of band structure the simulation of electron transport in the active region of THz QCL. Candidate make a claim the improvement to the coding of the programming. Candidate also makes a deep explanation of numerical study of narrow waveguide THz QCL to support broadband emission extensively the optical mode of the device.

Tandatangan (Signature):



Tarikh (Date): 24/12/2018

4.6 Keputusan dan perbincangan (*Results and discussions*)

According to the results obtained,

- a. Candidate not really develops new assumption and approach that can improve the THz output.
- b. The modelling results and discussion digested and compared with previous researcher.
- c. Candidate raises the issue of electron transport in the active region and the optical mode of the device.
- d. Schematic diagram shown almost well presented, but the graph of I-V not represents the good practice of plotting.

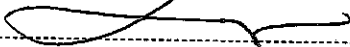
4.7 Kekuatan Tesis (*Strength of the thesis*)

The modelling results and discussion digested and compared with previous researcher.

Candidate raises the issue of electron transport in the active region and the optical mode of the device.

4.8 Kelemahan Tesis (*Weakness of the thesis*)

Candidate not really develops new assumption and approach that can improve the THz output.

Tandatangan (*Signature*):  Tarikh (*Date*): 24/12/2018

4.9 Kepentingan Kajian (*Significance of the study*)

The study "Simulation of Optical and Electronic Characteristics of Terahertz Quantum Cascade Laser" implies the importance of simulation study on Terahertz Laser devices to the output of the waveform. It can contribute to the development of THz Quantum Cascade Laser and human capital in this field. Hopefully it is used as the catalyst and reference point for further research.

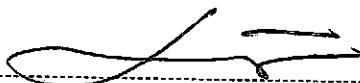
4.10 Perakuan penganugerahan (*Recommendation for the award*)

I hereby certify that the candidate be awarded the degree of Doctor of Philosophy subject to the amendments and corrections as listed elsewhere in this report being made in the thesis to the satisfaction of the internal/external examiners.

4.11 Lain-lain ulasan (*Other comments*)

Refer to the thesis.

Tandatangan (*Signature*):



Tarikh (*Date*): 24/12/2018



School of Graduate Studies

**PENGESAHAN SEMAKAN PEMBETULAN TESIS
(CERTIFICATION ON THE CORRECTION OF THESIS)**

CORRECTION: 1 / 2 / 3

EXTERNAL EXAMINER 1

Dekan
Sekolah Pengajian Siswazah
Universiti Teknologi Malaysia
81310 UTM Skudai
Johor
No. Faks: 07-5537800

Maklumat peperiksaan: (Diisi oleh SPS)

Tarikh viva (Date of viva): 21/062017

Tempoh pembetulan (Duration for correction): 3 bulan

Tarikh: 21 Okt 2019

Tuan (Dear Sir),

TAJUK TESIS (Title of Thesis) (Diisi oleh SPS): Simulation of Optical and Electronic Characteristics of Terahertz Quantum Cascade Laser

NAMA PELAJAR (Name of Student) (Diisi oleh SPS): Mohd Asmu'i Bin Mohd Akil

Fakulti (Faculty) (Diisi oleh SPS): Fakulti Sains

Semakan pembetulan: ~~Kedua~~ (Correction verification: ~~Second~~) (Diisi oleh SPS)



1. Dengan ini saya mengesahkan telah menyemak dan meneliti dan berpuas hati bahawa pelajar (I hereby certify that I have read and verified the thesis and satisfied that the candidate):

(Initial)

telah membuat segala pembetulan dan mencapai tahap sebagaimana yang dicadangkan oleh panel pemeriksa dan saya mengesyorkan pelajar di atas dianugerah Ijazah Sarjana/Doktor Falsafah (has done all the necessary corrections recommended by the Panel of Examiners and I recommend that the candidate be awarded Master/Phd* degree)

sedikit pembetulan yang hanya perlu disahkan oleh penyelia dan saya mengesyorkan pelajar di atas dianugerah Ijazah Sarjana/Doktor Falsafah (minor corrections need to be verified by the supervisor and I recommend that the candidate be awarded Master/Phd* degree)

2. Pelajar gagal membuat pembetulan sebagaimana yang dicadangkan oleh panel pemeriksa (The candidate failed to carry out all the necessary corrections recommended by the Panel of Examiners)
- i. membuat pembetulan ketiga dalam tempoh maksimum 3 bulan dan disemak semula oleh pemeriksa (redo correction). Berikan perincian maklumat pembetulan yang dikehendaki (Please provide details for the corrections needed) ✓

...Lihat lampiran – Laporan Pemeriksan Semula Tesis.

3. Pernyataan Lain (Other Remarks - if any):

Pengesahan dibuat oleh (Certified by):

Nama (Name): Prof Dr Mohd Kamil Abd Rahman,

Pemeriksa Luar/Pemeriksa Dalam* (External Examiner/Internal Examiner)*

Alamat (Address): Fakulti Sains Gunaan,

Universiti Teknologi MARA, Shah Alam, Selangor,

Perhatian (Attention):

Boleh dihantar dengan faks (xxxxxxx) untuk kegunaan segera tetapi salinan asal **MESTI** dihantar ke Sekolah Pengajian Siswazah. (This certification may be faxed (xxxxxxx) for urgent usage but the original copy **MUST** be sent to the School of Graduate Studies).



School of Graduate

PERINGATAN MESRA :

MOHON PROF. / DR. UNTUK MENGEMBALIKAN SEMULA BORANG SEMAKAN DAN TESIS PELAJAR SELEPAS SEMAKAN SELESAI KE SEKOLAH PENGAJIAN SISWAZAH(SPS)

CORRECTION: 1/2/3

**PENGESAHAN SEMAKAN PEMBETULAN TESIS
(CERTIFICATION ON THE CORRECTION OF THESIS)**

INTERNAL EXAMINER 1

Dekan
Sekolah Pengajian Siswazah
Universiti Teknologi Malaysia
81310 UTM Skudai
Johor
No. Faks: 07-5537800

Tarikh: 17/11/2019



Maklumat peperiksaan: (Diisi oleh SPS)

Tarikh viva (Date of viva): 21/06/2017

Tempoh pembetulan (Duration for correction): dua belas (12) bulan

Tuan (Dear Sir),

TAJUK TESIS (Title of Thesis) (Diisi oleh SPS): Simulation of Optical and Electronic Characteristics of Terahertz Quantum Cascade Laser

NAMA PELAJAR (Name of Student) (Diisi oleh SPS): Mohd Asmu'i Bin Mohd Akil

FAKULTI (Faculty) (Diisi oleh SPS): Fakulti Sains

Semakan pembetulan: **Pertama** (Correction verification: **First**) (Diisi oleh SPS)

1. Dengan ini saya mengesahkan telah menyemak dan meneliti dan berpuas hati bahawa pelajar:
(I hereby certify that I have read and verified the thesis and satisfied that the candidate):

(Initial)

telah membuat segala pembetulan dan mencapai tahap sebagaimana yang dicadangkan oleh panel pemeriksa dan saya mengesyorkan pelajar di atas dianugerah Ijazah Sarjana/Doktor Falsafah (has done all the necessary corrections recommended by the Panel of Examiners and I recommend that the candidate be awarded Master/Phd* degree)

sedikit pembetulan yang hanya perlu disahkan oleh penyelia dan saya mengesyorkan pelajar di atas dianugerah Ijazah Sarjana/Doktor Falsafah (minor corrections need to be verified by the supervisor and I recommend that the candidate be awarded ~~Master/Phd~~* degree)



2. Pelajar gagal membuat pembetulan sebagaimana yang dicadangkan oleh panel pemeriksa (The candidate failed to carry out all the necessary corrections recommended by the Panel of Examiners)

- i. membuat pembetulan kedua dalam tempoh maksimum 3 bulan dan disemak semula oleh pemeriksa (redo correction). Berikan perincian maklumat pembetulan yang dikehendaki (Please provide details for the corrections needed)

3. Pernyataan Lain (Other Remarks - if any):

Pengesahan dibuat oleh (Certified by):

Nama (Name): Yusof Muzajid
Pemeriksa Luar/Pemeriksa Dalam*/(External Examiner /Internal Examiner)*

Alamat (Address): 16, Jalan Timah 2,
Taman Sri Putri, Skudai
81300, Johor Bahru.

Perhatian (Attention):

Boleh dihantar dengan faks (07-5537800) untuk kegunaan segera tetapi salinan asal **MESTI** dihantar ke Sekolah Pengajian Siswazah. (This certification may be faxed (07-5537800) for urgent usage but the original copy **MUST** be sent to the School of Graduate Studies).

* Sila potong yang tidak berkenaan (*Delete where not applicable)



School of Graduate Studies

CORRECTION : 1 / 2 / 3

**PENGESAHAN SEMAKAN PEMBETULAN TESIS
(CERTIFICATION ON THE CORRECTION OF THESIS)**

EXTERNAL EXAMINER

Dekan
Fakulti Pengajian Siswazah
Universiti Teknologi Malaysia
81310 UTM Skudai
Johor
No. Faks: 07-5537800

Maklumat peperiksaan: (Diisi oleh SPS)
Tarikh viva (Date of viva): 21/06/2017
Tempoh pembetulan (Duration for correction): **dua
belas (12) bulan**

Tarikh: 15 Mei 2020

Tuan (Dear Sir),

TAJUK TESIS (Title of Thesis) (Diisi oleh SPS): Simulation of Optical and Electronic Characteristics of Terahertz Quantum Cascade Laser

NAMA PELAJAR (Name of Student) (Diisi oleh SPS): Mohd Asmu'1 Bin Mohd Akil

FAKULTI (Faculty) (Diisi oleh SPS): Fakulti Sains

Semakan pembetulan: Ke-Empat (ke-4) (Correction verification: 2 **Forth**) (Diisi oleh SPS)

RECEIVED
15 JUL 2020
School of Graduate Studies
(Initial)

1. Dengan ini saya mengesahkan telah menyemak dan meneliti dan berpuas hati bahawa pelajar:
(I hereby certify that I have read and verified the thesis and satisfied that the candidate):

telah membuat segala pembetulan dan mencapai tahap sebagaimana yang dicadangkan oleh panel pemeriksa dan saya mengesyorkan pelajar di atas dianugerah Ijazah Sarjana/Doktor Falsafah (has done all the necessary corrections recommended by the Panel of Examiners and I recommend that the candidate be awarded Master/Phd* degree)

sedikit pembetulan yang hanya perlu disahkan oleh penyelia dan saya mengesyorkan pelajar di atas dianugerah Ijazah Sarjana/Doktor Falsafah (minor corrections need to be verified by the supervisor and I recommend that the candidate be awarded Master/Phd* degree)

2. Pelajar gagal membuat pembetulan sebagaimana yang dicadangkan oleh panel pemeriksa (The candidate failed to carry out all the necessary corrections recommended by the Panel of Examiners)

i. membuat pembetulan ke-empat (ke-4) dalam tempoh maksimum **1 bulan** dan disemak semula oleh pemeriksa (redo correction). Berikan perincian maklumat pembetulan yang dikehendaki (Please provide details for the corrections needed)

...As stipulated in the thesis 4th examination report

3. **Penyataan Lain (Other Remarks - if any):** First thesis examination report was submitted in 18 April 2017 (before Viva) with 4 pages of plagerism identified, while 2nd and 3rd thesis examination reports were submitted on 22 Jan 2019 and 20 Oct 2019. So, this is the 4th thesis examination report.

Pengesahan dibuat oleh (Certified by):

Nama (Name): Prof. Dr. Mohd Kamil Abd Rahman
Pemeriksa Luar/Pemeriksa Dalam* (External Examiner/Internal Examiner)*

Perhatian (Attention):

Boleh dihantar dengan faks (07-5537800) untuk kegunaan segera tetapi salinan asal **MESTI** dihantar ke **Sekolah Pengajian Siswazah**. (This certification may be faxed (07-5537800) for urgent usage but the original copy **MUST** be sent to the **School of Graduate Studies**).

Alamat (Address): Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Selangor.

* Sila potong yang tidak berkenaan (*Delete where not applicable)