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FINAL REPORT

UNIDO-ICS TRAINING COURSE ON

PHOTONICS TECHNOLOGY FOR THE 21ST CENTURY: PRINCIPLES AND APPLICATIONS

November 23 - December 5, 1998

School of Electrical and Electronic Engineering
Nanyang Technological University, Singapore

Organized by
Nanyang Technological University (NTU), Singapore
International Center for Science and High Technology (ICS), Italy

Coordinators:
Dr. T. K. Lim, NTU, Singapore
Prof. G. Denardo - ICS, Italy

Sponsored by
International Center for Science and High Technology (ICS), Italy

Co-sponsored by
Photonics Research Group, Microelectronics Centre
School of Electrical and Electronic Engineering
Nanyang Technological University, Singapore

EXECUTIVE SUMMARY

The UNIDO-ICS Training Course on "Photonics Technology for the 21st Century: Principles and Applications" was successfully conducted from 23 November - 5 December 1998 at the School of Electrical and Electronic Engineering (EEE), Nanyang Technological University (NTU), Singapore. In this report, we review the various activities and highlight the major achievements.

There were 10 instructors and 56 registered participants. Six of the 10 instructors were staff of the Photonics Research Group (PRG), School of EEE, NTU, and the other 4 were invited speakers, with 2 from NTU and 2 from the United States. Among the 56 registered participants, 21 were from the Southeast Asian countries, 1 from China, and 34 from Singapore. Most overseas participants were from the universities and research institutions. On the other hand, all Singaporean participants were from the industry. Furthermore, in addition to the registered participants, more than 30 NTU staff and graduate students attended the course as non-registered participants.

During the two-week period of the course, the participants were involved in many activities. The technical program consisted of 48 hours of lectures on a wide range of topics, the lab visits to the laboratories in NTU, and the industrial visits to the Gintic Institute of Manufacturing Technology (Gintic) and the Productivity and Standards Board (PSB) of Singapore. Other activities included the Opening and Closing Ceremonies, the discussion sessions, and the social and cultural visits that were free, weekend activities.

The wide range of topics covered in the lectures had provided the participants with a good understanding and knowledge on the principles and applications of photonics technology. In addition, the lab visits had given them a better understanding on the research and education programs at NTU. Furthermore, the industrial visits to Gintic and PSB had provided the participants an opportunity to observe and understand the wide range of industrial R & D activities conducted at the national institutes in Singapore.

To foster closer interaction and promote future collaboration, two discussion sessions were organized, one each at the end of the first and second week. This activity provided the participants more opportunity for establishing linkages. In particular, the proposal for the formation of an Optics Association of Southeast Asia (OASA) was well received and a contact person for each country was appointed.

The Photonics Research Group (PRG) at the School of EEE, NTU, was set up in early 1994 to coordinate and spearhead research in the fields of photonics. Members of the PRG have been playing a leading role in Singapore and the Asia-Pacific region through the organization of international conferences and active participation in professional society activities. The successful organization of this training course, the first one of its kind in Singapore, is an important milestone in the evolution and growth of the PRG. It will have a significant impact to the education and training in photonics technology and will make a useful contribution to the R & D activities and the economic growth of the region.

Prepared by:

TK Lim 15/5/99

Dr. T. K. Lim Date
Training Course Coordinator

Approved by:

Prof. M. H. Er Date
Dean, School of EEE, NTU

17 MAY 1999

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1. INTRODUCTION

Photonics is emerging as one of the important enabling technologies of the future. Just as electronics revolutionized the entire industrial world from the 1960s, photonics, the technology of generating and harnessing light, is poised to drastically change the technological landscape in the 21st century.

Today, the applications of photonics encompass a very wide range, including communication, signal processing, data storage, remote sensing, manufacturing technology, and biomedical instrumentation. The purpose of this course was to provide the participants with the necessary working knowledge in the various areas of photonics technology. The participants were from a wide range of organizations, including educational institutions, government laboratories, and private companies involving in the manufacturing of precision optics or equipment that uses key optical components, and suppliers of optical components and systems. Also, the participants came from Singapore as well as other Southeast Asian countries. In particular, special efforts and emphases have been directed in attracting participation from the industrial sector, both in Singapore and in the region. Therefore, the successful conclusion of this course will have a significant impact to the education and training in photonics technology and will make a useful contribution to the R & D activities and the economic growth of the region.

2. OBJECTIVES

The objectives of this course were:

(a) To provide the participants with the necessary working knowledge in the various areas of photonics technology;

(b) To promote the applications of photonics technology for education, research, development, and manufacturing;

(c) To establish a network of people and institutions linking Singapore and the Southeast Asian countries;

(d) To develop a plan of action for future cooperation and collaborations

3. ADMINSTRATION

The course was sponsored and organized by the School of Electrical and Electronic Engineering (EEE), Nanyang Technological University (NTU), Singapore, and the International Center for Science and High Technology (ICS), Italy. The technical program was developed and conducted by the Photonics Research Group (PRG), Microelectronics Centre, School of EEE, NTU.

The coordinators of this program were:

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The program administrator was:

Centre for Continuing Education
Nanyang Technological University, Singapore

The members of the local Organizing Committee were:

Chair:	Dr. T. K. Lim
Secretary:	Dr. W. L. Goh, Dr. Y. C. Chan
Treasurer:	Dr. Y. Zhou, Dr. F. Zhou
Logistics:	Dr. P. Hui, Dr. T. K. S. Wong, Dr. B. S. Ooi
Publicity/Publications:	Dr. T. C. Au-Yeung, Dr. Y. L. Lam
Advisors:	Dr. C. H. Kam, Prof. H. S. Tan

4. INSTRUCTORS AND PARTICIPANTS

There were 10 instructors and 56 registered participants. Six of the 10 instructors were staff of the Photonics Research Group (PRG) and the other 4 were invited speakers, with 2 from NTU and 2 from the United States. Among the 56 registered participants, 21 were from the Southeast Asian countries (with 19 of them received full financial support), 1 from China, and 34 from Singapore. Most overseas participants were from the universities and research institutions. On the other hand, all Singaporean participants were from the industry. Furthermore, in addition to the registered participants, there were more than 30 NTU staff and graduate students who had attended certain sessions of the course as non-registered participants.

The breakdown of the number of registered participants by country is shown below:

Singapore	34
Malaysia	4
Indonesia	8
Thailand	5
Vietnam	3
Philippines	1
China	1

Lists of instructors and participants are included in Appendix 1 and Appendix 2, respectively.

5. TECHNICAL PROGRAM

5.1 Lectures

The duration of the course was from 23 November to 5 December 1998. There were 48 hours of lectures encompassing a wide range of topics. The topics covered, the number of lecture hours of each topic, and the corresponding lecturers are listed below:

First Week, 23-27 November 1998

Fundamentals of Optics (3 hours)..... Dr. Lim Tuan Kay

Optical Radiation Measurements (3 hours) ..... Dr. Lim Tuan Kay
Principles and Properties of Lasers (6 hours) ..... Dr. Lam Yee Loy
Semiconductor Lasers and Amplifiers (3 hours) ..... Dr. R. Nagarajan
Optical Metrology (3 hours) ..... A/P A. K. Asundi
Photonics & Opto-Electronics Integrated
Circuits (PIC & OEIC) (6 hours) ..... Dr. Ooi Boon Siew and
Dr. Chan Yuen Chuen

Second Week, 30 November - 4 December 1998

Fundamentals of Optical Fiber (3 hours) ..... Dr. Tjin Swee Chuan
Fiber Optic Sensors and Their Applications (3 hours) ..... Dr. Zhou Yan
Optical Fiber Communications (3 hours) ..... Dr. Lu Chao
Optical Signal Processing (6 hours) ..... Dr. Suganda Jutamulia
Laser Applications in Medicine (3 hours) ..... Dr. Tjin Swee Chuan
Optical Data Storage (I) (3 hours) ..... Dr. Zhou Yan
Optical Data Storage (II) (3 hours) ..... Dr. Lim Tuan Kay

The choice of these topics were based on both their technical merits and usefulness to the participants. The topics in the first week covered mostly the principles of photonics, while those in the second week dealt with the various areas of applications. The lecture notes were organized in two volumes, with one volume for each week, and with the same sequence as listed above. Due to other commitments of the instructors, there was some difference between the sequence of presentation and the sequence of course note organization. However, there was no difficulty in terms of continuity of presentation because the materials covered for each topic were mostly self-contained.

The program timetable for both weeks is given in Appendix 3. Note that each 3-hour session of lecture was divided into two 1.5-hour segments, with a 20-minute tea break in between.

5.2 Laboratory Visits

Besides the lectures, two afternoons were devoted for visits to the various laboratories at the School of EEE and the School of Mechanical and Production Engineering (MPE). During the first visit on Tuesday, 24 November 1998, the participants visited the Photonics Labs, the Ion Beam Processing Lab, the Hybrid Microcircuits Lab, and the Clean Room and Characterization Lab. These four labs are all within the Microelectronics Centre of the School of EEE. In the second visit on Friday, 4 December 1998, the participants visited the IC Design Lab and the Network Technology Research Centre (NTRC) in the School of EEE, and the Strength of Materials Lab in the School of MPE. Through these visits, the participants had gained a broader understanding on the research and education programs at NTU.

The schedules for the two laboratory visits are shown in Appendix 4.

5.3 Industrial Visits

In addition to the two laboratory visits as stated above, two industrial visits were also organized. The first visit, on Wednesday, 25 November 1998, was to the Gintic Institute of Manufacturing Technology (Gintic, for short) inside NTU campus and the second visit, on Wednesday, 2 December 1998, was to the Productivity and Standards Board (PSB) of Singapore, in the Singapore Science Park. The program of these visits is shown in Appendix 5.

Gintic is one of the 13 national research institutes funded by the National Science and Technology Board (NSTB) of Singapore. It was formed in 1993 by a merger between the Gintic Institute of CIM and the Institute of Manufacturing Technology. The major tasks of the institute are to: perform applied R & D in identified processes and technologies to propel

Singapore's manufacturing industry into the 21st century; upgrade the local-based manufacturing companies to remain competitive; transfer technical results from applied R & D to the local-based manufacturing community. More information on Gintic could be obtained from its website: http://www.gintic.gov.sg.

The PSB is a statutory board set up in April 1996, as a result of a merger between the National Productivity Board (NPB) and the Singapore Institute of Standards and Industrial Research (SISIR). Through this merger, PSB has integrated the functions of these two organizations. It has also taken over the small and medium enterprises (SMEs) development function from the Economic Development Board (EDB). The place visited by the participants is the premise of the former SISIR, located at 1 Science Park Drive, Singapore Science Park. More information on PSB could be obtained from its website: http://www.psb.gov.sg.

6. OTHER ACTIVITIES

6.1 Opening and Closing Ceremonies

The Opening Ceremony was the very first activity of the program, starting at 9:00 a.m. on Monday, 23 November 1998. After a brief introduction by Dr. T. K. Lim, Course Coordinator, Prof. M. H. Er, Dean of the School of EEE, delivered the Welcoming Address, and Dr. T. Kurobuchi, ICS Program Officer, presented the Keynote Address.

In the Welcoming Address, Prof. Er thanked UNIDO and ICS for their support of the course, commented on the Organizing Committee for their dedication and hard work in the successful organization of the course, and thanked all participants for their participation. He also gave a brief overview on NTU, the mission of the School of EEE, and the research activities of the Photonics Research Group.

In the Keynote Address, Dr. Kurobuchi gave a review on the founding of ICS, its mandate and missions, and the various programs and activities sponsored by ICS over the past few years.

The Closing Ceremony served as the official conclusion of the training course. The ceremony started at 5:30 p.m. on Friday, 4 December 1998. After a brief introduction by Dr. T. K. Lim, Dr. L. C. Wong, Director of Materials Technology Application Centre, PSB, gave a presentation on "Optics Towards the 21st Century - Future Actions for Singapore", emphasizing the important relationship between R & D and technology transfer and management. Following this, Dr. C. H. Kam, Vice Dean, Academic, and Head, Microelectronics Division of the School of EEE, delivered the Closing Address, and Prof. M. H. Er presented the Certificate of Participation to all participants who had attended both weeks of the course. A total of 21 overseas participants and 3 Singapore participants were awarded the certificate. The certificate bears the signatures of Prof. M. H. Er, Dr. G. Denardo, and Dr. T. K. Lim, and has the logos of UNIDO, ICS, NTU, and the School of EEE. A sample copy of the certificate is shown in Appendix 6.

Following the Closing Ceremony, a buffet dinner was hosted at the Function Hall, Hall 7, a student residence near the School of EEE. The dinner lasted for more than two hours, providing the participants another opportunity for interaction and networking.

6.2 Meeting at the Productivity and Standards Board

Dr. T. Kurobuchi, accompanied by Dr. T. K. Lim, visited PSB and had a meeting with Dr. L. C. Wong and Dr. J. K. Fu. Dr. Wong is the Director, Materials Technology Application Centre, Technology Development Division, and Dr. Fu is Head, Thin Film Section, Materials Processing Centre. The main purpose of the meeting was to establish connection between ICS and PSB for developing future collaborations. Indeed, there are ample opportunities for

cooperation and collaboration since there are plenty of common interests and activities between the two institutions.

6.3 Discussion Sessions with the Participants

To foster closer interaction and promote future collaboration, two discussion sessions were organized. The first session was on Friday, 27 November 1998, beginning at 4:00 p.m., and the second session on Friday, 4 December 1998, starting at 4:30 p.m. Dr. T. K. Lim chaired both sessions.

The first session was at the conclusion of the first week's technical program and was also joined by Dr. Kurobuchi. All overseas participants and a few Singaporean participants attended the session. Representatives from Indonesia, Malaysia, the Philippines, Thailand, and Vietnam gave a brief overview on the research and education programs of the universities and industry in their home countries. The main accomplishment of this meeting was that through these presentations, the participants had gained a better understanding on each other.

The second discussion session was at the conclusion of the technical program of the course, preceding the Closing Ceremony. Besides the overseas and local participants, a few people from PSB, including Dr. L. C. Wong and Dr. J. K. Fu, also attended. The main purpose of the meeting was to have the participants' comment and feedback on the program of the course and to discuss the opportunity for future cooperation and collaboration. In general, the participants all agreed that overall the course had achieved its objectives. On the other hand, there were a few areas that could be improved. For example, some participants stated that the two-week duration of the course was too long and that a one-week course may be more appropriate. It was also suggested that laboratory demonstrations and hands-on sessions could have been included in the program.

To facilitate the development of future cooperation and collaboration among the Southeast Asian countries, Dr. T. K. Lim proposed the formation of an Optics Association of Southeast Asia (OASA). The proposal was well received and, as a result, the following representatives agreed to serve as the contact persons:

Dr. T. K. Lim, Singapore
Dr. Shaari Shabudhin, Malaysia
Dr. Masbah Siregar, Indonesia
Dr. Totarong Pain, Thailand
Prof. Rosello Lyndon H. Roble, Phillippines
Prof. Pham Van Hoi, Vietnam.

Dr. T. K. Lim was appointed the main contact person, due to his experience as the Founding Chair of the Singapore Chapter of SPIE - The International Society for Optial Engineering and his service as the Chair of the Chapter since 1995.

6.4 Social and Cultural Visits

To allow the overseas participants the opportunity to explore and enjoy the multi-cultural society of Singapore, no technical activity was scheduled on Saturdays and Sundays. Indeed, the participants had enjoyed very much these days of free activities, especially those who came to Singapore for the first time. Many of them had said that they will certainly visit Singapore again.

7. PROGRAM EVALUATION

7.1 Course Organization

The organization of the course started with the submission of the first proposal to ICS in May 1998. Subsequently, more details, including the budget, were worked out and the course announcement was drafted. In the meantime, mailing lists were acquired from ICS, PSB, and SPIE. The first batch of announcement was sent out in the end of September 1998 to individual potential participants and to UNIDO offices in the Southeast Asian countries. Extensive contacts were also made through e-mail within Singapore.

Response to the course announcement was very good that over 40 applications were received from overseas and over 50 were from Singapore. Indeed, it was a difficult task for selecting only 20 overseas participants since all applicants are well qualified. For local participants, the task was much easier since no support for travelling and living expenses was required and, therefore, it was possible to accept more than 20 applicants. In the end, 22 people from overseas and 34 from Singapore had registered and attended the course. In addition, over 30 staff and graduate students of the University had attended as non-registered participants.

Among the 22 overseas participants, 19 received full financial support for travelling and living expenses. Accommodation at the University staff residence was provided to the participants, and meals were provided at the University canteens throughout the duration of the course. In general, the participants were satisfied with all these arrangements.

7.2 Technical Program

The technical program of the course included lectures, visit to University laboratories, and industrial visits to Gintic and PSB, as reported in Section 5. The wide range of topics covered in the course had provided the participants with a good understanding and knowledge on the principles and applications of photonics technology. In addition, the visits to the laboratories of the Schools of EEE and MPE had given them a better understanding on the research and education programs at NTU. Furthermore, the industrial visits to Gintic and PSB had provided the participants an opportunity to observe and understand the wide range of industrial R & D activities conducted at the national institutes in Singapore.

The criterion for the selection and organization of the topics was to provide a comprehensive coverage on both the principles and applications of photonics technology. The instructors were selected based on their knowledge of the subject matter. Organization and presentation of course materials for each topic were mostly self-contained so that reference to other topics was not required although all topics are related. This approach should prove beneficial for the participants in using the course notes as reference materials in their work.

Most participants were satisfied that the course materials were well prepared and presented, and that, overall, the course objectives had been achieved. On the other hand, it was suggested that there were a few areas that could be improved. For example, some participants stated that the two-week duration of the course was too long. It was also recommended that laboratory demonstrations and hands-on sessions could have been included.

7.3 Follow Up Actions

Based on the connection established through this course, an important follow up action is to maintain the contact among the participants towards the formation of the Optics Association of Southeast Asia (OASA). At the post-course meeting of the Organizing Committee held on 12 December 1998, it was suggested that, to embrace a wider scope of the association, it would be more appropriate to name it as the Photonics Association of Southeast Asia (PASA).

Another important follow up action is to prepare and submit articles about the course to the following publications: *Productivity Digest*, *OE Reports*, *NTU News*, and *E^3 World*. The *Productivity Digest* is a monthly magazine published by PSB and distributed to all companies in Singapore. The *OE Reports* is SPIE's monthly newspaper which is distributed

worldwide to all the 12,000 SPIE members and other institutions. *NTU News* is a quarterly newsletter of NTU distributed to all NTU staff and to government and industrial institutions in Singapore. Finally, the *E^3 World* is the newsletter published by the School of EEE, NTU for the staff and students of the School, but also distributed to outside organizations. Therefore, the publicity of the course through these media will be an effective promotional effort for the photonics technology as well as for UNIDO, ICS, and NTU.

9. CONCLUSIONS AND RECOMMENDATIONS

This training course has been a rewarding experience for the members of the Organizing Committee, as well as the course instructors and participants. Through the dedication and hard work of all the people involved the program was conducted and concluded successfully. Besides the valuable learning experience, connections among the participants have been established. In particular, the proposal for the formation of an Optics Association of Southeast Asia (OASA) will have a significant impact on the future development of photonics technology and its applications in Singapore and the region.

Judging from the success of this training course, it is recommended that similar course be organized in the future, with the following modifications in the technical program:

(1) The duration of the course be shortened to one week. To accommodate this, the course will be more focused to a particular topic or to several topics sharing a common application area.

(2) The lectures be complemented by laboratory demonstration and hands-on sessions. These will enable the participants to gain practical experience for applying the knowledge learnt from the lecture.

(3) To allow more active participation from industry, invitations for guest speakers and sponsorship could be solicited from companies actively engaged in R & D. A technical exhibition may also be organized for companies to showcase their products.

10. ACKNOWLEDGEMENT

The Organizing Committee would like to thank UNIDO, ICS and NTU for their sponsorship, all the instructors and the participants for their support, and all other people for their assistance, especially the following individuals:

Ms. Vanessa Varnier , Secretary, ICS; Prof. Daniel Tint Lwin, Director, Centre for Continuing Education (CCE), NTU; Ms. Jowe P. L. Chu, Administration Officer, CCE; Mr.. T. H. Chia, Administration Officer, Bursar's Office, NTU; Mr. K. L. Yong, Technician, Photonics Lab I, NTU; Ms. Serene G. H. Lim, Technician, Engineering Materials Lab, NTU; Ms. Debbie H. K. Chia, Technician, First Year Lab C, NTU; Dr. K. Pita, Senior Scientific Officer, Thin Films Section, Materials Processing Centre, PSB; Dr. L. C. Wong, Director, Materials Technology Application Centre, Technology Development Division, PSB; Dr. J. K. Fu, Head, Thin Film Section, Materials Processing Centre, PSB; Dr. Z. P. Fang, Research Officer, Machine Vision and Sensors Technology Group, Automation Technology Division, Gintic; and Dr. A. M. Fong, Director, Automation Technology Division, Gintic.

Appendix 1 List of Instructors

(1) Instructors Associated with the Photonics Research Group (PRG)
School of Electrical and Electronic Engineering (EEE)
Nanyang Technological University

Dr. Y. C. Chan, Lecturer
Dr. Y. L. Lam, Senior Lecturer
Dr. T. K. Lim, Senior Lecturer
Dr. B. S. Ooi, Lecturer
Dr. S. C. Tjin, Senior Lecturer
Dr. Y. Zhou, Senior Lecturer

(2) Invited Speakers:

Dr. C. Lu, Senior Lecturer
Network Technology Research Centre (NTRC)
School of Electrical and Electronic Engineering (EEE)
Nanyang Technological University

A/P A. K. Asundi, Director
Sensors and Actuators Program
School of Mechanical and Production Engineering (MPE)
Nanyang Technological University

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USA

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Appendix 2 List of Participants

Overseas Participants

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2. Mr. CHAITAVON Khunat
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   Bangkok Thailand.

3. Ms. CHAN Wai Yee
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   Kuala Lumpur
   Malaysia

4. Mr. HARYO Subowo
   Indonesia Telecommunication Industry (INTI)
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   Indonesia

5. Mrs. IDA Suryani
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Shanghai, P.R. China.

22. Dr. ZAIN Hamdani
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Jakarta-Pusat.
Indonesia.

Singapore Participants

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Singapore

2. Mr Chia Tat Weng
Centre For Signal Processing
Singapore

3. Mr. Jim Chia
Millice Pte Ltd
Singapore

4. Mr. Choc Cheng Soon George
APP Systems
Singapore

5. Mr. Chu Kin
Leica Instruments (S) Pte Ltd
Singapore

6. Mr. Chua Teck Huat, Steven
Mitsubishi Chemical Singapore
Singapore

7. Mr. Chua Teow Tzing
Avimo Electro-Optics Pte Ltd
Singapore

8. Mr. Ekman Chew Wee Meng
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9. Dr. Fang Zhong Ping
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11. Mr. Gu Guan Qing
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14. Mr. Lai Chung Peng
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15. Dr. Lai Kin Seng
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17. Mr. Liu YuanJie
Singapore Productivity & Standards Board
Singapore

18. Mr. Loke Mun Hong
Leica Instruments (S) Pte Ltd
Singapore

19. Ms. Low Siok Pheng
Singapore Productivity & Standards Board
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20. Mr. Ng Boon Sin
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31. Dr. Van Haasteren Arjan J. P.
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33. Ms. Wu Ruifen
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34. Dr. Xu Gan
Singapore Productivity & Standards Board
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Appendix 3 Program Timetable

(1) Program of the Course

First Week, 23-28 November 1998 (Venue: LT26, NTU)

Day	Morning (9.00 am - 12.20 pm)	Afternoon (1.30 - 4.50 pm)
Monday	**Registration and Opening Ceremony**	
	Principles and Properties of Lasers (I)	Principles and Properties of Lasers (II)
Tuesday	Fundamentals of Optics	**Lab Visit I** [See Note below]
Wednesday	Semiconductor Lasers and Amplifiers	**Industrial Visit I - Gintic**
Thursday	Optical Radiation Measurements	Optical Metrology
Friday	Photonics & Opto-Electronics	Photonics & Opto-Electronics
	Integrated Circuits - PIC & OEIC (I)	Integrated Circuits - PIC & OEIC (II)
Saturday	**Social & Cultural Visit I**	

(Note: In Lab Visit I, the participants will visit the labs in the Division of Microelectronics, School of EEE, including the Photonics Lab.)

Second Week, 30 November - 5 December (Venue: LT24, NTU)

Day	Morning (9.00 am - 12.20 pm)	Afternoon (1.30 - 4.50 pm)
Monday	Optics in Medicine (See Note 1)	Optical Signal Processing (I)
Tuesday	Optical Signal Processing (II)	Fiber Optic Fundamentals & Sensors (I)
Wednesday	Fiber Optic Fundamentals & Sensors (II)	**Industrial Visit II - PSB**
Thursday	Optical Fiber Communications	Optical Data Storage (I)
Friday	Optical Data Storage (II)	**Lab Visit II** (See Note 2)
Saturday	**Social and Cultural Visit II**	

(Note 1: Registration will begin at 8:45 am for those participants who attend only the second week.

Note 2: In Lab Visit II, the participants will visit the labs in the School of EEE, excluding those already visited in the first week.)

(2) Daily Schedule:

9.00 am	Morning Session Begins
10.30 am	Tea Break
10.50 am	Course Resumes
12.20 pm	Lunch Break (1 Hr 10 Min)
1.30 pm	Afternoon Session Begins
3.00 pm	Tea Break
3.20 pm	Course Resumes
4.50 pm	End Of Day

Appendix 4 Laboratory Visits

Lab Visit I, Tuesday, 24 November 1998

(All laboratories are within the Microelectronics Centre, School of EEE)

1:30pm-2:30pm	Photonics Lab I and II
2:30pm-3:30pm	Ion Beam Processing Lab (each group half an hour)
2:30pm-3:30pm	Hybrid Lab (each group half and hour)
3:30pm-4:30pm	Clean Room and Characterisation Lab

Lab Visit II, Friday, 4 December 1998

1:30 - 2:15 p.m.	Network Technology Research Centre (NTRC) School of EEE
2:15 - 2:45 p.m.	IC Design Lab School of EEE
2:45 - 3:30 p.m.	Strength of Materials Lab School of MPE

Appendix 5 Industrial Visits

Visit to Gintic Institute for Manufacturing Technology
Wednesday, 25 November 1998

2.00 pm	Welcome Address by Dr Fong Aik Meng, Automation Tech Div. Director Auditorium, Tower Block, Level 3
2.10 pm	Gintic Video Presentation
2.20 pm	General Discussion
2.30 pm	Facilities Tour TOWER BLOCK - CAM Centre (Machine Vision Lab) by Dr Fang Zhong-Ping VALLEY BLOCK - Laser Lab - Precision Machining Lab by Dr G C Lim - Welding Lab by Mr PH Mohan
4.00 pm	End of Visit

Visit to Productivity and Standards Board, Singapore
Wednesday, 2 December 1998

14:00 pm	Welcome address, SP Lounge
14:05 pm	Presentation (about 10 minutes each): Thin Films Technology Metrology (Optics/Photonic) PEAC (Plastic Optics)
14:35 pm	Lab. Tour (Thin Films and Metrology) Visitors will be divided into 4 groups.
16:00 pm	Back to SP Lounge for discussion
16:30 pm	End

Certificate of Participation

Awarded to

(Name of participant)

for successful completion of

UNIDO-ICS TRAINING COURSE ON PHOTONICS TECHNOLOGY FOR THE 21ST CENTURY: PRINCIPLES & APPLICATIONS

NANYANG TECHNOLOGICAL UNIVERSITY
School Of Electrical & Electronic Engineering

23 November - 5 December 1998, Singapore

Prof. Meng-Hwa Er, Dean
School of Electrical and Electronic Engineering
Nanyang Technological University

Prof. G. Denardo, Coordinator
International Centre for Science and
High Technology

Dr. Tuan-Kay Lim, Training Course Coordinator
School of Electrical and Electronic Engineering
Nanyang Technological University