The Institution of Engineers, Malaysia
Board of Engineers, Malaysia

IEM/BEM
GRADUATE EXAMINATION REGULATIONS

Revised for March 2011 Examinations

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IEM/BEM GRADUATE EXAMINATION REGULATIONS

PREFACE

The IEM/BEM Graduate Examinations is for assessment of candidates for admission to Graduate membership of The Institution of Engineers, Malaysia. This Graduate Examination is organised by The Institution of Engineers, Malaysia and supported by the Board of Engineers, Malaysia. The IEM/BEM Graduate Examinations Committee is set up to regulate the Examinations in accordance to these Regulations.

The IEM/BEM Graduate Examinations is conducted solely to comply with the requirements for Graduate membership of The Institution of Engineers, Malaysia and hence to registration as Graduate Engineers with the Board of Engineers, Malaysia.

The objective of holding the IEM/BEM Graduate Examinations is to provide an opportunity for Malaysians to achieve professional status through local professional examinations. The IEM/BEM Graduate Examinations is also used as a "top-up" for unrecognised engineering degrees and to change or add discipline for membership or registration purposes.

All correspondence in connection with the above IEM/BEM Graduate Examinations should be addressed to:-

Hon. Secretary
The Institution of Engineers, Malaysia
P. O. Box 223 (Jalan Sultan)
46720 Petaling Jaya
Selangor

SECTION A : GENERAL

1. EXTRACTS FROM THE CONSTITUTION AND BY-LAWS OF THE INSTITUTION OF ENGINEERS, MALAYSIA

Constitution Article 3.5

The Council may conduct examinations, or approve examinations in appropriate subjects to be conducted on their behalf for approved candidates for admission as Graduates or Members, as shall be prescribed in the Bylaws and Regulations.

SECTION IIIC Examinations

Bylaws Section 3.29

The Council may conduct examinations or approve in whole or in part particular university degrees and other academic qualifications as demonstrating a sufficient standard of education and may grant such exemption from the Institution Examinations as it thinks fit.

Bylaws Section 3.30

The Council may cause to be held examinations including the examination of theses for candidates for election, or transfer.

Bylaws Section 3.31

The Council may make Examination Regulations governing the times and places at which examinations shall be held, the subjects which they shall comprise, the fees to be paid and the conditions under which candidates may be admitted thereto. Such Regulations shall also govern the preparation and submission of theses.

Bylaws Section 3.32

The Council may permit a person who is not a candidate for admission, election or transfer to present himself for examination and if he passes such examination, the Council may exempt him wholly or partly from further examination if he subsequently applies for admission, election or transfer.

2. INTRODUCTION

It is expected that the majority of professional engineers will have undertaken a full-time or sandwich course leading to a degree. However, there is a need for the Council of the Institution to conduct its own examination, to serve as an academic assessment for those who have prepared themselves for the engineering profession in other ways.

The Examination can also be the criteria against which the standard of other academic qualifications, which candidates for the profession may offer in satisfaction of the Bylaws, can be assessed.

An applicant for Graduate Membership who holds qualifications not meeting the full requirements for admission to Graduate membership will be assessed according to an individual case procedure and he/she may be required to sit a number of subjects**.**

Exemption from part or whole of the Institution's Examination may be given to persons holding academic qualifications, including degrees in engineering or science, which are considered as being an adequate standard for the purpose of membership of the Institution.

The scope and standard of the Part 1 Examination is that expected of an undergraduate at the end of the second year of a four-year accredited engineering degree programme.

The scope and standard of the Part 2 Examination is that expected of an undergraduate at the end of the final year of a four-year accredited engineering degree programme.

The academic training required for registration as a professional engineer must include not only the theoretical study of engineering science but also the applications of such theory to practical problems.

It is highly recommended that candidates for the Part 2 Examination attend a formal course of preparation for the subjects in which they are interested, unless specifically exempted by the Institution.

The Part 3 Examination comprises essentially of a project as well as 12 months of structured and mentored industrial training programme that provides an avenue for a mentee to apply, enhance and integrate skills, knowledge and discipline acquired in Part 1 and Part 2 stages in professional engineering practice and management through an immersion into a real job-running environment aimed at developing applied professional skills, judgement and undertaking, and concludes with an assessment by Professional Engineers appointed by IEM/BEM Examination Bureau of a training log of recorded and assembled training casework, a training report and an oral presentation of salient features of the training.

3. PROGRAMME OBJECTIVES

The objective of the IEM/BEM Graduate Examination is to produce graduates who have successfully passed an academic assessment that is aimed at:

i. enabling those who have prepared themselves for the engineering profession in other ways to join the Institution.

ii. enabling those who hold qualifications not meeting the full requirements for admission to Graduate membership of the Institution and Graduate Engineer registration with BEM to meet the requirements.

iii. enabling engineers to change or add practice disciplines.

4. PROGRAMME OUTCOMES/ATTRIBUTES

On successfully passing the Examination, the candidate is expected to be able to:

A. apply the knowledge of science and engineering fundamentals;
B. handle work related to a specific engineering discipline with in-depth technical competence;
C. undertake problem identification, formulation and solution;
D. utilise systems approach to design and evaluate operational performance;
E. apply the principles of design for sustainable development;
F. take on professional and ethical responsibilities and be committed to them;
G. communicate effectively, not only with engineers but also with the community at large;
H. function effectively as an individual and in a group with the capacity to be a leader or manager ;
I. undertake the social, cultural, global and environmental responsibilities of a professional engineer; and
J. recognise the need to undertake life-long learning, and possessing/acquiring the capacity to do so.

SECTION B: EXAMINATION REGULATIONS

Part 1

1. CONDITIONS OF EXAMINATION

Candidates must satisfy the Examiners in the specified number of subjects as per ***Appendix A***.

2. QUALIFICATIONS FOR ADMISSION

Candidates for admission to Part 1 must satisfy the Institution that they have already achieved a standard of education as listed below.

i. STPM - at least 2 passes in Mathematics and/or Science subjects; or

ii. an accredited Diploma programme; or

iii. an appropriate qualification approved by Institution.

All candidates shall have at least one year of working experience in engineering employment. *Candidates who do not satisfy the pre-requisite of one year working experience are required to provide evidence that they have undertaken a formal course of study in the principles of engineering including laboratory work and a course in engineering drawing.*

3. APPLICATION FORM

All candidates before applying to sit for the Part 1, must satisfy the Institution that they fulfill the requirements for admission to the Examination by submitting the Application Form.

Application forms for the Examination should be obtained from the Institution. Candidates should ensure that completed application forms are received by the Institution before the end of August of the year preceding the Examination they propose to take. The Institution will inform applicants whether they are acceptable as candidates for Part 1 and whether any exemptions are granted and, where appropriate, will issue the necessary Registration Form.

Candidates must attempt the Examination within ***three (3) years*** of their application being approved. Candidates who do not sit for the Examination within this period must submit a new Application Form to the Institution.

4. REGISTRATION

Prospective candidates must be registered for the IEM/BEM Graduate Examinations before being permitted entry to the Part 1 examinations. A Registration Form will be forwarded to the candidates in late September or early October of the year. The completed Registration Form must be submitted to the Institution together with the appropriate registration fee as required.

The Institution will issue successful applicants with a correspondence number, an Examination Entry Form and a list of entry fees. The correspondence number must be quoted in all communications with the Institution.

5. REQUIREMENTS OF EXAMINATION

Candidates must complete Part 1 within ***four (4) attempts*** spread over ***six (6)*** successive calendar years.

An attempt at the Examination is defined as the receipt and acceptance by the Institution of a completed examination entry form on or before the closing date for receipt of entries.

6. SELECTION OF PAPERS

Candidates may sit for the examination by attempting a minimum of three papers at their first attempt.

7. AWARD OF CREDITS

Candidates will be credited with a pass in each subject in which they satisfy the Institution.

Candidates must accumulate the number of subject credits required for Part 1 of the Examination ~~in~~ ***within*** four (4) attempts in six (6) successive years.

8. EXAMINATION ENTRY FORM

Candidates must complete the Examination Entry Form to sit for any attempt.

9. SPECIAL CASE

Candidate**s,** unable to complete the Part 1 Examination in six (6) successive years due to illness or other unavoidable exceptional circumstances may make an application to the Institution, at the ***end of the six-year period*** for special permission to make one further attempt. Such applications must be supported by documentary evidence.

Candidates who have completed their four attempts but have one more subject still outstanding in Part 1 may make one further attempt in the outstanding subject (with approval from the Institution) at the next Examination.

Candidates who wish to repeat a credited subject to obtain a higher grade of pass may do so within, or subsequent to, the allowed attempts.

Part 2

1. CONDITIONS OF EXAMINATION

Candidates must satisfy the Examiners in the specified number of subjects as per ***Appendix B***.

2. QUALIFICATIONS FOR ADMISSION

Candidates for admission to Part 2 must satisfy the Institution that they:

i. have passed Part 1
ii. have gained a qualification recognised by the Institution as granting exemption from Part 1 and have had at least one year of working experience in engineering employment.

3. APPLICATION FORM

An applicant who has passed Part 1 of this Examination will be given the Registration Form for Part 2. No further submission of Application Form and assessment fee will be required.

Candidates applying directly to sit for Part 2 must satisfy the Institution that they fulfill the requirements for admission to the examination by submitting the Application Form.

Application Forms for the Examination should be obtained from the Institution. Candidates should ensure that completed Application Forms are received by the Institution before the end of August of the year preceding the Examination they propose to take.

The Institution will inform applicants whether they are acceptable as candidates for Part 2 and whether any exemptions are granted and, where appropriate, issue the necessary Registration Forms.

Candidates must attempt the Examination within three years of their application being approved. Candidates who do not sit the Examination within this period must submit a new Application Form to the Institution.

4. REGISTRATION

Prospective candidates must be registered for the IEM/BEM Graduate Examination before being permitted entry to the Part 2 examinations. A Registration Form will be forwarded to the candidates in late September or early October of the year. The completed Registration Form must be submitted to the Institution together with the appropriate registration fee as required.

The Institution will issue successful applicants with a correspondence number, an Examination Entry Form and a list of entry fees. The correspondence number must be quoted in all communications with the Institution.

5. REQUIREMENT OF EXAMINATION

Candidates must complete Part 2 ***within four (4) attempts*** spread over ***six (6)*** successive calendar years.

An attempt at the Examinations is defined as the receipt and acceptance by the Institution of a completed examination entry form on or before the closing date for receipt of entries. Candidates who are unable to make an attempt need to obtain approval from the Institution.

Candidates would be deemed to have successfully completed the Part 2 after completing all the required subjects to the satisfaction of the Examiners.

6. SELECTION OF PAPERS

Candidates may sit for the examination by attempting a minimum of three papers at their first attempt sitting.

7. AWARD OF CREDITS

Candidates will be credited with a pass in each of the subjects in which they satisfy the Institution.

Candidates must accumulate the number of subject credits required for Part 2 of the Examination ~~in~~ **within** four (4) attempts in six (6) successive years.

Candidate, who fail to complete the Part 2 Examination within the period of the permitted number of attempts, may apply to re-enter the Examination via fresh applications. Subject credits awarded during the previous series of attempts will not be carried forward.

8. EXAMINATION ENTRY FORM

Candidates must complete the Examination Entry Form to sit for any attempt.

9. ***SPECIAL CASE***

Candidate**s,** unable to complete the Part 2 Examination in six (6) successive years due to illness or other unavoidable exceptional circumstances may make an application to the Institution, at the ***end of the six-year period*** for special permission to make one further attempt. Such applications must be supported by documentary evidence.

Candidates who have completed their four attempts but have one more subject still outstanding in Part 2 may make one further attempt in the outstanding subject (with approval from the Institution) at the next Examination.

Candidates who wish to repeat a credited subject to obtain a higher grade of pass may do so within, or subsequent to, the allowed attempts.

Part 3

1. CONDITIONS OF EXAMINATION

The candidate MUST obtain at least one year of supervised industrial training relevant to the candidate's discipline in engineering after passing Part 2. The evidence must be in the form of a letter issued by the employer of the firm/organization and a report endorsed by a Professional Engineer/Corporate Member of The Institution of Engineers, Malaysia (PEng/MIEM). The assessment should include a report of the candidate's practical experience.

2. QUALIFICATIONS FOR ADMISSION

Candidates for admission to Part 3 must satisfy the Institution that they have passed Part 2.

3. REGISTRATION

Candidates shall register for the industrial training on successful completion of Part 2. An applicant who has passed Part 2 of this Examination will be given the Registration Form for Part 3.

Prospective candidates must be registered for the IEM/BEM Graduate Examination before being permitted entry to the Part 3 examinations. A Registration Form will be forwarded to the candidates in late September or early October of the year. The completed Registration Form must be submitted to the Institution together with the appropriate registration fee as required.

The Institution will issue successful applicants with a correspondence number, an Examination Entry Form and a list of entry fees. The correspondence number must be quoted in all communications with the Institution.

4. SUPERVISED INDUSTRIAL TRAINING

Candidates would be deemed to have completed the Part 3 after completing the training to the satisfaction of the Institution. The assessment would be based on the candidate's report and assessor's report. Candidates must submit evidence within two years of their application being approved. Candidates who do not submit the documents within this period must submit a new Registration Form to the Institution.

Candidates would be deemed to have completed the Part 3 after completing the training to the satisfaction of the Institution.

5. AWARD OF CREDITS

Candidates must accumulate 12 months of supervised industrial training required for Part 3 over period of not exceeding 2 years. Candidates will be credited with a pass in supervised industrial training in which they satisfy the Institution.

The Institution may specify additional period of supervised industrial training or resubmission of the report if the report and/or training are not satisfactory. Failing to satisfy the Institution, the candidate will have to re-register for industrial training.

6. SPECIAL CONSIDERATION

Candidates unable to complete Part 3 due to illness or other unavoidable exceptional circumstances may make an application to the Institution, at the ***end of the two-year period*** for special permission to extend the period of supervised industrial training. Such applications must be supported by documentary evidence.

SECTION C : GENERAL EXAMINATION

1. GENERAL INFORMATION

a) All examination question papers will be set in English and must be answered in that language. Each paper is of three-hour duration.

b) When attending the Examination, candidates must show means of personal identification in addition to the admission slip. Candidates unable to do so may be refused admission to the examination. ***Candidates arriving at the examination hall more than 30 minutes after the time set for the start of the examination will not be admitted***.

c) No candidate may leave the Examination Hall during the first and the last 30 minutes of the examination period.

d) Candidate must provide themselves with:-

Writing and ordinary drawing instruments

Electronic ***Non-programmable*** calculator (*Subject to any limitation set by the Institution from time to time*).

Please note that PDAs and handphones are not allowed.

The Institution, except where candidates are notified individually to provide specified materials, will provide all other required materials.

e) No other electronic devices, printed or written materials may be taken into examination hall. Any candidate so doing may be disqualified and be barred from entry to subsequent Examinations.

2. TRANSITION ARRANGEMENTS

Candidate who has taken the examination made under the previous Regulations will continue to be governed by those regulations until the end of the three years.

3. CANDIDATES WITH EXEMPTIONS

Candidates required to pass a limited number of subjects in Part 1 or Part 2 must do so within the requirements of these Regulations and within the time period stipulated on granting the exemption.

4. EXAMINATION DATES AND CENTRES

a) The Examination, both Parts 1 and 2 will be held annually (normally in the month of May) at identified centres.

b) The Examination will be set on such days and at such places as the Institution might determine from time to time.

5. FINAL DATES FOR RECEIPT OF APPLICATION FORMS

a) Application Form for permission to enter Parts 1, 2 and 3 or for exemption from the Parts 1 and 2 should be received at the Institution by 1 September of the year preceding the examination.

b) The closing date for receipt, at the Institution, of completed Examination Entry Form and entry fees for both Parts of the examination is 30 November of the year preceding the examination.

c) It is the responsibility of candidates to ensure that their completed Examination Entry Forms are submitted to the Institution together with the entry fees to arrive on, or before, the appropriate closing dates i.e. by 30 November of the year preceding the examination for receipt of entries.

d) All forms must be sent by Registered Post or Recorded Guaranteed Delivery or delivered by personal visit to the Institution. Official receipts must be obtained, as the Institution will not consider any claims that a form has been overlooked or lost unless proof of posting is produced.

e) Examination Entry Form received after the stated closing date may be considered as late entries and such candidates shall be required to pay a late entry fee in addition to the standard fee for each subject. However, acceptance of late entries would be at the discretion of the Institution.

f) The submission of a completed Entry Form is the candidate's acknowledgement that the Examination Regulations have been read and understood.

6. EXAMINATION FEES

a) Each Entry Form must be accompanied by the appropriate entry fee as set out by the Institution from time to time.

b) Cheques, Bankers' Draft and Money Orders for the entry fee inclusive of the center fee must be made payable in Ringgit Malaysia to "***IEM Examinations Account"***.

c) Entry Forms received without the appropriate fees will not be accepted under any circumstances.

7. ABSENTEES AND WITHDRAWALS

a) Candidates who notify in writing the Institution before the appropriate closing date for receipt of entries that they are withdrawing from the Examination will have the examination fee refunded less an amount to cover the administrative costs.

b) Candidates whose notice of withdrawal is received by the Institution after the appropriate closing date for receipt of entries or who fail to attend the Examination will not have any part of their entry fee refunded.

c) Examination entry fee will not be refunded if candidates fail to attend the Examination.

d) Late entry candidates are not allowed to withdraw and the examination entry fee (including the late entry fee) will not be refunded if candidate withdraws from the Examination.

8. CHANGES TO CENTRES OR SUBJECTS

The Institution will not consider any application from a candidate to change the choice of examination center or in the subjects selected after the appropriate closing date for receipt of entries.

9. COMPLETION OF ENTRY FORMS

a) Candidates must complete fully each part of the Entry Form in accordance with these Regulations and any additional instructions sent with the Entry Form.

b) Examination Entry Forms that are completed incorrectly will not be accepted.

10. ACKNOWLEDGEMENT OF ENTRY

Candidates will receive an examination timetable from the Institution in acknowledgement that their entries have been accepted.

11. EXAMINATION TIME-TABLE AND ADMISSION SLIPS

a) Admission slips stating the date, time and place of the examination will be sent by the Institution to reach the candidate approximately two weeks before the Examination.

b) If the admission slip has not been received by one week before the Examination, a candidate must contact the Institution by the most urgent means of communication available giving his/her correspondence number, full name and address and the examination centre selected.

c) Candidates must inform the office of the Institution of any changes in address.

12. RESULTS

a) The result will be sent by post during late August or early September and ***no information will be given over the telephone*** or by other means.

b) Each subject will be marked out of 100. The result of a candidate's performance in each subject attempted will be indicated by a grade as follows:

MARK	**GRADE**	
70+	A	
60 – 69	B	
50 – 59	C	
40 – 49	D	***PASS***
0 – 39	F	***FAIL***

c) For Projects and Industrial Training, the marking scheme would be either PASS or FAIL. Candidates are required to pass both the written report and the presentation in order to be awarded a PASS.

d) Results announced by the IEM/BEM Graduate Examinations Committee are final. The Institution will not entertain any correspondence with regard to the Examination results.

13. EXAMINATION CERTIFICATE

IEM/BEM Examination Certificate will be awarded by The Institution of Engineers, Malaysia jointly with the Board of Engineers, Malaysia to all candidates who have successfully completed each part of the Examinations.

A full certificate will also be awarded upon completion of all requirements of the examination.

Part 1 Examination

ALL DISCIPLINES

Compulsory

CG101	Engineering Mathematics	C101
CG102	Engineering Materials I	C102
CG103	Engineering Science	C103
CG104	Computer Applications in Engineering	
CG201	Engineering Perspectives and Skills	C104&300A
CG202	Management for Engineers	D223

Option

Select **TWO (2)** from the following:

CM101	Engineering Mechanics	C105
CM102	Thermodynamic, Fluid & Process Engineering	D206
CE101	Electrical and Electronic Engineering	C107
CE102	Software and Information Systems Engineering	
CK101	Chemistry for Engineers	-
CC101	Hydraulics and Hydrology	D204

Part 2 Examination

CIVIL ENGINEERING

Compulsory

DC201	Fluid Mechanics	D203
DC202	Mechanics of Solids	D209
DC203	Structural Analysis	D210
DC204	Structural Design	D211
DC205	Geotechnical Engineering	D213
DC206	Surveying	

Option

Select **TWO (2)** from ***Category 2***

ELECTRICAL ENGINEERING

Compulsory

DE201	Electrical Fields and Circuits	D215
DE202	Electrical Machines and Drives	D216
DE203	Electrical Power Systems	D217
DE204	High Voltage Engineering System	-

DE205	Communication System	-
DE206	Control Systems Engineering	D227

Option

Select **TWO (2)** from ***Category 2***

MECHANICAL ENGINEERING

Compulsory

DM201	Dynamics of Mechanical Systems	D225
DM202	Applied Thermodynamics	D201
DM203	Heat Transfer	D202
DM204	Machine Design	-
DM205	Statics and Dynamics	-
DC201	Fluid Mechanics	D203

Option

Select **TWO (2)** from ***Category 2***

CHEMICAL ENGINEERING

Compulsory

DC201	Fluid Mechanics	D203
DK201	Instrumentation and Control	
DK202	Heat, Mass and Momentum Transfer	D202
DK203	Materials and Energy Balance	-
DK204	Separation Processes	D205
DK205	Chemical Thermodynamics, Kinetics and Reactor Design	D206
DK206	Plant and Equipment Design	

Option

Select **TWO (2)** from ***Category 2***

CATEGORY 2

DG201	Engineering Materials II	D208
DG202	Mathematics	D224
DG203	Engineering Economics	-
DC207	Highway and Transportation	-
DC208	Construction Engineering	-
DC209	Built Environment	-
DE207	Electrical Energy Utilisation	-
DM205	Quality and Reliability Engineering	D220
DM206	Manufacturing Technology	D226
DM207	Mechanical and Structural Engineering	
DK207	Health, Safety and Environment	-
DG207	Computer Aided Engineering	-

SUBJECT CG101 – ENGINEERING MATHEMATICS I

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content is about the application of fundamental mathematical techniques in the analysis of engineering systems.

AIM

To equip the candidate with the fundamental mathematics needed to analyse and solve a range of engineering problems.

PREREQUISITES

Refer to General Guidelines.

LEARNING OUTCOMES

A candidates should be able to:

(i) use advanced calculus for the mathematical solution of engineering problems.

(ii) solve engineering problems using linear algebra.

(iii) use discrete mathematics for engineering analysis.

(iv) apply probability and statistical principles in engineering applications.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
    i. deductive and inferential reasoning
    ii. algebraic manipulation
3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

<u>Outcome 1</u> Use advanced calculus for the mathematical solution of engineering problems.

The candidates are able to:

1. Use and apply sequences and series including Taylor's series
    a. general geometric series
    b. infinite series
    c. convergent and divergent sequences and series
    d. power series

e. binomial series
f. Taylor's Theorem and series

2. Apply functions of two or more variables to problem solving
   a. products
   b. quotients
   c. implicit functions
   d. parametric equations
   e. partial differentiation
3. Apply complex numbers to problem solving using
   a. graphical representation
   b. Cartesian, polar and exponential forms
   c. DeMoivre's theorem

4. Use vector algebra techniques for solving 3-D spartial problems
   a. components of vectors, scalar and vector products
   b. equations of lines and planes

5. Use differential and integral calculus of functions of one variable
   a. curvature
   b. maxima, minima and points of inflection
   c. inverse trigonometric functions
6. Solve ordinary differential equations of first order
   a. by separation of variables
   b. using integration factor (linear equations)
   c. using trial solution (linear equation with constant coefficients)
   d. using Complementary Function and Particular Integral
7. Solve higher-order linear differential equations with constant coefficients
   a. identify Complementary Function and Particular Integral
   b. use the trial functions for CF and PI
   c. use Laplace Transforms
8. Find coefficients of Fourier series arising in engineering problems
   a. formulae for sine and cosine coefficients
   b. identify even and odd functions

Outcome 2 Solve engineering problems using linear algebra.

The candidates are able to:

1. Perform matrix algebra operations
   a. product of matrices
   b. determinants
   c. calculate the inverse matrix
   d. row reduction
   e. determine rank of a matrix
2. Solve linear simultaneous equations relevant to engineering systems
   a. systematic elimination of variables
   b. row reduction of augmented matrix
   c. inconsistency, unique and multiple solutions related to matrix rank
3. Solve eigenproblems arising from engineering applications
   a. find eigenvalues by solving the characteristics equation
   b. find eigenvectors for known eigenvalues

Outcome 3 Use discrete mathematics for engineering analysis.

The candidates are able to:

1. Manipulate and simplify Boolean expressions arising from switching circuitry etc.

a. truth tables
b. de Morgan's rules

Outcome 4 Apply probability and statistical principles in engineering applications.

The candidates are able to:

1. Determine mean, standard deviation and variance of discrete and continuous probability distributions
2. Calculate sample statistics arising from engineering production inspection
3. Linear regression
4. Calculate conditional probabilities
5. Relate the binomial distribution to expansions and calculate probabilities, mean and variance
6. Relate distributions to histogram representation
7. Calculate probabilities for a Poisson distribution
8. Calculate probabilities from the Normal distribution

SUBJECT CG102 - ENGINEERING MATERIALS I

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content is about the structures, properties and application of a range of materials used in engineering including metals and non-metals.

AIM

To provide engineers of all disciplines with an understanding of the structures, properties and appropriate uses of engineering materials.

PREREQUISITES

Refer to General Guidelines.

LEARNING OUTCOMES

A candidate should be able to:

(i) explain the structures of materials, polymers and ceramic materials.

(ii) assess the mechanical and physical properties of engineering materials.

(iii) describe the relationships between the structure of a material and its properties.

(iv) identify suitable materials for engineering applications.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards the skills in the following areas:

1. Develop a strategy for using skills in problem solving over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required when tackling one complex problem with at least three options.
3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, using a variety of methods.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Explain the structures of materials, polymers and ceramic materials.

The candidates are able to:

1. Recognise materials structures which are
   a. crystalline

b. glassy/ amorphous

2. Use and interpret phase diagrams
3. Use phase diagrams to predict the materials microstructures
4. Outline the influence on materials properties of
   a. grain size
   b. phase distribution
   c. molecular linkages
5. Analyse the effect of dislocations and point defects on plastic flow in metals

Outcome 2 Assess the mechanical and physical properties of engineering materials.

The candidates are able to:

1. Describe the mechanical properties of engineering materials
   a. tensile and shear strength
   b. elastic modulus
   c. hardness
   d. toughness
   e. ductility
2. Assess the methods used to perform tests on materials to determine mechanical properties values using
   a. tensile test
   b. impact test
   c. crack tip displacement test
   d. hardness test
   e. fatique test
   f. creep test
3. Interpret result of the above test and use as criteria for material selection
4. Describe the effect of the following on the mechanical properties of materials
   a. temperature extremes
   b. environment
   c. age
5. Define the describe the electrical characteristics of engineering materials
   a. conductivity and resistivity
   b. intrinsic and extrinsic semi-conductors
   c. the p-n junction
   d. field effect
   e. diode and transistors
   f. dielectrics and permittivity
   g. magnetism
   h. Hall effect
   i. superconductivity
6. Describe the methods used to perform tests to determine the following electrical properties of engineering materials
   a. conductivity and resistivity
   b. permittivity
   c. magnetism
7. Define and describe the thermal properties of engineering materials
   a. conductivity
   b. expansion
   c. heat capacity

Outcome 3 Describe the relationships between the structure of a material and its properties

The candidates are able to:

1. Assess the impact on the structure and properties of a metal due to
   a. alloying

   b. heat treatment
   c. cold working and performing
   d. thermal cutting and joining techniques
   e. mechanical production processes
2. Interpret phase diagrams for alloy materials
3. Predict the effect of temperature on the structure and properties of
   a. plastics
   b. cements
   c. composites
4. Assess the effect on the hardness of aluminium alloys due to
   A. aging
   b. precipitation
5. Recognise the effect on the properties of steels of the following heat treatment process
   a. normalising
   b. annealing
   c. hardening
   d. tempering

Outcome 4 Identify suitable materials for engineering applications.

The candidates are able to:

1. Determine the suitability of a specific material or range of materials for engineering applications involving
   a. mechanical loading
   b. electrical and thermal conductivity
   c. extremes of temperature
   d. structural integrity
   e. strength the weight ratio
   f. wear resistance

2. Identify materials appropriate to their industrial application
   a. aeronautical engineering
   b. mechanical engineering
   c. power generation
   d. heat transfer and applications
   e. automotive industry
   f. structural engineering
   i. chemical engineering
   j. electrical engineering
   k. construction industry

SUBJECT CG103 - ENGINEERING SCIENCE

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content provides candidates with an understanding of the concepts necessary to undertake calculations for problems in engineering.

AIM

To enable the candidate to solve both simple and complex problems encountered on a day-to-day basis by professional engineers. Engineering science mainly constitutes applied mathematics, data analysis, experimental testing and previously investigated phenomena and one of the aims is to develop an analytical approach to problem solving.

PREREQUISITES

Elementary differential calculus and differential equations. Elementary integral calculus.
Physics to a level broadly equivalent to A-level; although several of the topics below are included in an A-level syllabus, they are to be revised and taken to slightly greater depth here. Concepts of force, moment and friction. Position and velocity calculations for systems with constant acceleration. Voltage, current, resistance (Ohm's Law)

LEARNING OUTCOMES

A candidate should be able to:

(i) develop scientific concepts which aid solutions to engineering problems.

(ii) appreciate the idealisation of physical problems using simple mathematical models.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards the Key Skills in the following areas:

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:

    i. deductive and inferential reasoning
    ii. algebraic manipulation
3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

<u>Outcome 1</u> Develop scientific concepts which aid solutions to engineering problems

The candidates are able to:

1. Determine equilibrium of
    a. particle

   b. a solid body
2. Calculate equilibrium forces and reactions
3. Determine forces in simple statically determinate assemblies of rigid bodies
4. Construct and use free body diagrams
5. Determine equations of conditions
6. Ccalculate
   a. direct stress
   b. extensional strain
   c. Young's modulus
7. Calculate
   a. shear stress
   b. shear strain
   c. shear modulus
8. Analyse principle stresses and strains related by elastic stiffness matrix
9. Solve problems using Poisson's ratio
10. Solve problems using bulk modulus
11. Use concepts of
   a. impulse
   b. momentum
   c. work
   d. power
   e. kinetic and potential energy
12. Apply Newton's Laws of motion to constant force problems
13. Apply Newton's Laws for rotation about a fixed axis
14. Determine the result of collisions between particles
15. Ddetermine hydrostatic
   a. pressure
   b. static force balances
16. Solve problems using Archimedes' principle
17. Solve thermodynamics problems using the First Law of Thermodynamics or the steady flow energy equation involving
   a. heat and work
   b. temperature
   c. internal energy
   d. enthalpy
   e. flow and non-flow processes
   f. perfect gases
18. Solve electrical problems involving
   a. charge
   b. capacitance
   c. inductance
   d. reluctance
   e. electric and magnetic fields
   f. principles of electromagnetism
19. Analyse passive dc circuits
20. Solve problems using Kirschoff's Laws
21. Discriminate between ac and dc and understand generation and rectification
22. Design simple
   a. diode circuits
   b. transistor circuits

Outcome 2 Appreciate the idealisation of physical problems using simple mathematical models.

The candidates are able to:

1. Formulate simple mathematical models that aid the solution of scientific problems in engineering.
2. Ascertain by trial whether a mathematical model is appropriate to a particular engineering problem.
3. Use simple mathematical models as an aid to problem solving.

SUBJECT CG201 - ENGINEERING PERSPECTIVES AND SKILLS

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content is about the development of perspectives and skills required to achieve success as an engineer.

AIM

To develop the technical and non-technical skills essential to the professional engineer in a period of fast moving technological change. These skills include communication and presentation skills essential in the world of work.

PREREQUISITES

Elementary knowledge of the S.I. system of units.
Basic use of tables and graphs.

LEARNING OUTCOMES

A candidate should be able to:

(i) define the characteristics and responsibilities of professional engineers.

(ii) explain the function, philosophy and process of engineering design.

(iii) use appropriate planning and evaluation methods for engineering projects.

(iv) apply appropriate engineering communication methods.

(v) apply the appropriate computational tools for engineering applications.

(vi) solve engineering problems using mathematical modelling and computer simulation techniques.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards the Key Skills in the following areas:

1. Develop a strategy for using application of number of skills over an extended period of time
2. Monitor progress and adapt the candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
    a. Deducting and inferential reasoning;
    b. Algebraic manipulation
3. Evaluate your overall strategy and present the outcomes from the candidate's work, including use of charts, diagrams and graphs to illustrate complex data;
4. Develop a strategy for using skills in problem solving over an extended period of time;
5. Monitor progress and adapt the candidate's strategy, as necessary, to achieve the quality of outcomes required when tackling one complex problem with at least three options.
6. Evaluate the candidate's overall strategy and present the outcomes from the candidate's work using a variety of methods.
7. Develop a strategy for using communication skills over an extended period of time.

ASSESSMENT

A three-hour written examination and 30 minutes oral presentation. A pass in the Oral Presentation is required.

CONTENT

Outcome 1: Define the characteristics and responsibilities of professional engineers.

The candidates are able to:

1. Define professionalism
2. Assess the types and levels of qualification relevant to
   a. technician
   b. technical assistant
   c. engineering technologist
   d. professional engineer
3. Explain the role of professional bodies in
   a. maintaining levels of competence in engineering
   b. maintaining best practice
   c. influencing industrial practices
   d. developing forums for ideas and debates
   e. acting as a technical information source
4. Assess the responsibility of the engineer in society
   a. developing new products
   b. managing the pollution to the environment
   c. generating national wealth
   d. managing finite resources and sustainability
   e. occupational safety and health
5. Assess the desirable characteristics of a professional engineer
   a. combination of logic and flair
   b. analytical approach to problems
   c. inventive and resourceful
   d. mathematically competent
   e. adept communicator

Outcome 2 Understand the function, philosophy and process of engineering design.

The candidates are able to:

1. Identify the main steps in the design process
2. Describe appropriate models of the design process and the various stages from design concept to presentation
3. Describe the nature and role of different types of model in engineering design
4. Use computer design packages
5. Describe the legal requirements relating to recruitment, employment and training; taxation, insurance, pensions; product liabilities and guarantees, sales of goods and services; indemnity
6. Explain the responsibility of an engineer with regard to professional codes:
   a. requirement of skill and care as a defence against malpractice and negligence;
   b. duty owed to employer, colleagues, workforce, customer and general public;
   c. legal constraints and liabilities;
   d. responsibility to avoid pollution waste of material and financial assets;
   e. danger to the environment;
   f. licensing and registration;
   g. codes of practice.

Outcome 3 Use appropriate planning and evaluation methods for engineering projects.

The candidates are able to:

1. Use project evaluation and review techniques (PERT)
2. Control projects by applying critical path methods (CPM)
3. Evaluate projects using discounted cash flow techniques (NPV and IRR)
4. Identify the major factors in risk analysis and its management
5. Present business data using a balance sheet and basic financial accounting techniques
6. Implement decision processing taking account of uncertainty
7. Discuss the contribution of engineering products and services to the generation of wealth including export, imports and trade balances, levies, duty and trade agreements.

Outcome 4 Use appropriate engineering communication methods.

The candidates are able to:

1. Communicate engineering ideas and solutions using
   b. sketches
   c. drawings
   d. diagrams
   e. models
2. Produce engineering drawings using
   a. first and third angle
   b. drawing conventions and symbols
   c. dimensioning
   d. tolerancing
3. Represent systems using
   a. block diagrams
   b. flow charts
   c. logic networks
4. Write technical reports using appropriate methods, structure and content.
5. Present technical information in a suitable form for meetings, seminars, video conferencing and publications.
6. Address an audience using presentation skills and techniques appropriate to the situation.

Outcome 5 Understand the basic aspects of computation and their application in engineering

The candidates are able to:

1. Input and output to computers
2. Use high and low level computer languages
3. Write basic in-line code in a high level computer language
4. Use structured programming
5. Operate a computer using
   a. word processing
   b. spreadsheets
   c. databases
   d. graphics

Outcome 6 Solve engineering problems using mathematical modelling and simulation techniques

The candidates are able to:

1. Use appropriate mathematical modelling techniques
2. Use appropriate simulation techniques
3. Use numerical methods to differentiate, integrate, solve equations and to fit curves

SUBJECT CG202 – MANAGEMENT FOR ENGINEERS

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content is about the management principles, organisational structures, performance measurement and control of issues of particular relevance to engineering, technology and the operations management of engineering projects.

AIM

To develop the candidate's awareness of the functions of management in the control and execution of engineering projects including planning, cost and time management.

PREREQUISITES

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LEARNING OUTCOMES

A candidate should be able to:

(i) demonstrate the process involved in engineering project management.

(ii) demonstrate the techniques required to procure projects.

(iii) apply control techniques during the project execution.

(iv) describe the managerial functions, roles and responsibilities.

(v) recognise the issues, difficulties and problems facing management and how to address them

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards the Key Skills in the following areas:

1. Develop a strategy for using application of number of skills over an extended period of time
2. Monitor progress and adapt the candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
    - Deducting and inferential reasoning;
    - Algebraic manipulation
3. Evaluate your overall strategy and present the outcomes from the candidate's work, including use of charts, diagrams and graphs to illustrate complex data;
4. Explore the key demands of the work and formulate viable proposals for meeting these demands.
5. Plan to manage the work, meet the skill-development needs and gain the necessary commitment from others.
6. Manage the work, adapting the strategy as necessary to resolve at least two complex problems and achieve the quality of outcomes required. Formally review, with an appropriate person, the candidate's use of skills in:
    - Communication
    - Problem solving
    - Working with others
7. Evaluate the candidate's overall performance and present the outcomes, including at least:
    - One formal, oral presentation of the outcomes from the work

- One written evaluation of the candidate's overall approach
- Application of skills

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Demonstrate the process involved in engineering project management.

The candidates are able to:

1. Describe the nature and structure of the engineering project industry.
2. Describe the engineering project cycle.
3. Identify the roles and functions of relevant parties.
4. Describe the various engineering project companies organisational formats and departmental roles within it.
5. Describe the contractual relationships and the project procurement process.
6. Assess types of contract.

Outcome 2 Demonstrate the techniques required to procure projects.

The candidates are able to:

1. Identify and prepare the documentation required at the tendering stage.
2. Describe the tendering and estimating process.
3. Use estimating methods
   a. unit rate and operational estimating
   b. direct and indirect costs
   c. preliminaries
   d. overheads
   e. tender adjustment
4. Prepare pre-tender planning and method statements.

Outcome 3 Apply control techniques during the project execution.

The candidates are able to:

1. Develop cost control measures
   a. total budget and sub-budgets
   b. S curves and cash flow forecasting
   c. cost control coding
   d. reporting systems
   e. standard costs and variances
   f. indices and price adjustments
   g. interim evaluators
   h. claims
2. Apply arbitration, adjudication and alternative dispute resolution.
3. Implement various types of engineering project planning and know their relationship to stages of the engineering project process.
4. Use planning methods
   a. bar charts
   b. critical path networks
   c. line of balance
5. Use methods of resource estimation
   a. scheduling
   b. allocation
6. Monitor and record changes.

7. Take corrective action.
8. Define performance.
9. Implement key performance indicators.
10. Explain the cost/time/quality triangle.
11. Define productivity.
12. Measure and improve productivity through work study
    a. method study
    b. work measurement
13. Organise site work
    a. selection of engineering project plant
    b. plant maintenance policies
    c. site layout
    d. materials management
    e. Construction (Design and Management)
    f. Health and Safety issues and regulations
    g. quality management
        i. principles
        ii. application

Outcome 4 Describe the managerial functions, roles and responsibilities.

The candidates are able to:

1. Recognise the nature of organisations
    a. types of business
    b. business objectives, strategy and policy
    c. legal requirements of business
2. Recognise the impact of technology on society.
3. Appreciate technology transfer and technology strategy.
4. Illustrate the structures, functions and roles within contemporary business organisations.
5. Prepare financial reports
6. Define the roles of and skills required for management
    a. leadership
    b. motivation
    c. team work and team building
7. Chart professional development and career advancement.
8. Appreciate the professional issues in management.
9. Describe the generic issues in project management environments.
10. Recognise classical techniques for project management.
11. Control resource scheduling, budgeting and cost control.
12. Assess the risks in project management.
13. Investigate human factors and team issues in project management.
14. Present and analyse business data (descriptive statistics not statistical inference).
15. Use decision analysis techniques
    a. decision trees
    b. Expected Monetary Value (EMV)
    c. Expected Value of Perfect Information (EVPI)
16. Assess the value of information.
17. Describe optimisation principles
    a. LP (Linear Programming) formulation
    b. Graphic solutions
18. Use simulation principles for analysing business problems.
19. Use forecasting techniques.

Outcome 5 Recognise the issues, difficulties and problems facing management and how to address them.

The candidates are able to:

1. Recognise the management issues within and across business functions.

a. marketing and sales
    i. market research
    ii. the marketing process
    iii. customer focus
    iv. quality
b. managing the design and product development process
c. procurement, purchasing and supply chain management
d. human resource management
e. job design and work organisation
f. productivity and work measurement
g. performance measurement
h. continuous improvement
i. Japanese management principles
j. knowledge and information management

2. Recognise issues facing contemporary organisations
    a. ethics and corporate responsibility
    b. engineering Health and Safety at Work
    c. legal requirements
    d. environmental issues
    e. international business and the impact of globalisation

SUBJECT CM101 – ENGINEERING MECHANICS

(This syllabus is valid for examinations from March 2011)

SUMMARY

The subject is about the skills required to function effectively in the fields of mechanical and structural engineering.

AIM

To develop the knowledge and skill necessary to solve simple but realistic mechanical and structural design problems.

PREREQUISITES

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LEARNING OUTCOMES

A candidate should be able to:

(i) Demonstrate an understanding of basic concepts and scientific principles applicable to problems in mechanical and structural engineering.
(ii) Apply methods of analysis used in simple mechanical and structural problems.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt canddiate's strategy, as necessary, to achieve the quality of outcomes required in the work involving:
    i. Deductive and inferential reasoning
    ii. Algebraic manipulation
3. Evaluate candidate's overall strategy and present the outcomes from candidate's work, including use of charts, diagrams and graphs to illustrate complex data.
4. Develop a strategy for using skills problem solving over an extended period of time.
5. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required when tackling complex problems.
6. Evaluate candidate's strategy and present the outcomes from candidate's work using appropriate methods

ASSESSMENT

A three-hour written examination.

CONTENT

<u>Outcome 1</u> Understand basic scientific principles applicable to problems in mechanical and structural engineering

The candidates are able to:

1. Statistic
    a. determine forces in statically determination pin-jointed structures
        i. Graphical techniques
        ii. Resolution of forces at joint

iii. Method of sections
b. recognise the necessary conditions for statistical determinacy

2. Stress and Strain
   a. Determine relationship between stresses at a point
      i. Analyse biaxial stress systems
      ii. Evaluate principles stresses
      iii. Use Mohr's stress circle
   b. Recognise relationship between elastic constants
   c. Calculate strain energy
3. Theory of beams
   a. Solve problems involving point and distributed loads on beams
      i. Construct shear force and bending moment diagrams
      ii. Calculate second moment of area
      iii. Develop moment- stress-curvature relationship for symmetric elastic prismatic beams
   b. Calculate second moment of area
   c. Develop solutions for slopes and deflection for
      i. Simply supported beams using Macaulay's method
      ii. Cantilever beams using Macaulay's method
   d. Solve statically inderterminate problems
   e. Use symmetry to aid beam problem solving
   f. Apply techniques to minimise bending moment
   g. Solve baem-bending problems by superposition of standards solutions
   h. Select structural sections from standard tables
4. Torsion of circular-section shafts
      i. Determine polar second moment of area
      ii. Determine torque-shear stress-twist relationships for circular elastic bars
      iii. Determine effect of combined bending and torsion on circular-section shaft
5. Kinematics
   a. Construct velocity and acceleration diagrams for the motion of a rigid body
   b. Use diagrams to find velocities and accelerations in simple assemblies of rigid bodies including
      i. Pins
      ii. sliders
   c. Determine an instantaneous centre
   d. Use Cartesian and polar co-ordinates to determine
      i. Displacement
      ii. Velocity
      iii. Acceleration
   e. Construct vector representation of
      i. Position
      ii. Velocity
      iii. Acceleration
   f. Determine moving frames of reference and relative motion
6. Dynamic
   a. Use formulae and understand concepts of
      i. Impulse
      ii. Momentum
      iii. Work
      iv. Power
      v. Energy
   b. Determine of motion of a body subject to varying forces
   c. Determine the effects of collisions between bodies
   d. Calculate centre of mass of rigid bodies
   e. Calculate moment of inertia of rigid bodies
   f. Calculate angular momentum
   g. Assess the dynamic of plane rigid bodies on impact
7. Vibration
   a. Assess simple harmonic motion of undamped systems with one degree of freedom
      i. pendulum
      ii. Mass

iii. Spring

b. Assess damping and damped motion of systems with one degree of freedom
   i. Mass
   ii. Damper
   iii. Spring

c. Determine the transient response to simple inputs
d. Determine the steady state sinusoidal response in vibration systems
e. Use phases to aid problems solving

Outcome 2 Apply Methods of analysis used in simple mechanical and structural problems

The candidates are able to:

1. Solve practical problems in statistic using
   a. Calculation
   b. Graphical methods
   c. Model
2. Solve practical problems in stress and strain using
   a. Calculators
   b. Scientific tests
3. Solve practical problems in simply supported and cantilevered beams using
   a. Calculus
   b. Graphical means
   c. Load tests
   d. Tables and charts
4. Solve practical problems in kinematics using
   a. Mathematics
   b. Laboratory techniques
5. Solve practical problems in dynamic using
   a. Mathematics
   b. Laboratory techniques
6. Solve practical problems involving vibrations using
   a. Mathematical
   b. Models
   c. Practical laboratory investigation

SUBJECT CM102 – THERMODYNAMIC, FLUID AND PROCESS ENGINEERING

(This syllabus is valid for examinations from March 2011)

SUMMARY

The subject is about the chemistry and chemical engineering concerned with the theormodynamics and kinetics of chemical reactions, the thermodynamics of phase behaviour, and the design of chemical reactors.

AIM

To provide fundamental principles of chemical kinetics and reaction engineering necessary for the purpose of designing chemical reactors.

PREQUISITIES

-

LEARNING OUTCOMES

A candidate should be able to:

(i) appreciate and analyse chemical thermodynamics and phase equilibria.
(ii) appreciate and analyse the kinetics of chemical reactions.
(iii) understand heterogeneous catalysed reaction.
(iv) appreciate and design chemical reactors.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILL AND COMPETENCIES

-

ASSESSMENT

A three hour written examination

CONTENT

Outcome 1 Appreciate and analyse chemical thermodynamics and phase equilibria.

The candidates are able to:

1. Appreciate the concept of reversible work free energy
2. Calculate the temperature and pressure dependence of free energies
3. Determine free energy functions
4. Describe and calculate fugacity and activity
5. Appreciate the standard-state concept
6. Assess quantitatively free energy and equilibrium
7. Describe phase equilibria
8. Determine t and p dependence off free energies
9. Apply the gibbs-helmholtz equation
10. Determine solubilities of solids, liquids and gases
11. Apply raoult's and henry's laws
12. Determine activity coefficients
13. Use the gibbs-duhem equation and perform thermodynamic tests

14. Ascertain chemical equilibrium and determine t and p dependence
15. Recoqnize and be able to calculate, using of data
    a. standard free energies
    b. enthalpies
    c. entropies
16. Assess equilibrium constants
17. Describe gas and liquid phase reaction with t and p dependence
18. Investigate reversible electrochemical cells and standard electrode potentials
19. Appraise concentration cells
20. Analyse experimental determination of thermodynamic data

Outcome 2 Appreciate and analyse the kinetics of chemical reactions.

The candidates are able to:

1. Use simple homogeneous rate equations
2. Assess overall rates
3. Analyse temperature dependence of reaction rates
4. Apply the arrhenius equation and understand the role of an activated complex
5. Determine
    a. equilibrium constants
    b. rate constants
    c. free energy of activation
    d. activation energy and frequency factors
6. Analyse collision theory and frequency factors
7. Interpret experimental result, determine reaction order and calculate activation energies
8. Understand parallel and consecutive reactions
9. Apply the concept of rate limiting steps
10. Determine the effect of temperature on relative rates of competing processes
    a. reaction
    b. diffusion
11. Assess reaction which are
    a. chain
    b. isothermal
    c. adiabatic
12. appreciate free radicals

Outcome 3 Understand heterogeneous catalysed reaction.

The candidates are able to:

1. Analyse physical adsorption chemisorption
2. Determine the enthalpy of adsorption and dependence of surface coverage on temperature and pressure
3. Determine surface areas by langmuir and bet isotherms
4. Determine adsorption coefficients
5. Apply rate equations of simple reactions
    a. first and second order
    b. adsorption- desorption controlled
    c. surface reaction controlled
6. Assess the significance of the specific rate constants in reactions

Outcome 4 Appreciate and design chemical reactors

The candidates are able to:

1. Assess tubular reactors
2. Investigate the solution of the elementary equation based on plug for isothermal and

adiabatic cases

3. Assess continuous stirred-tank reactors (CSTR)
4. Assess design equations based on the perfect mixing assumption in CSTRs
5. Compare stirred tank and tabular reactors
6. Apply residence time studies to reactors
7. Compare batch and continuous processes with regard to
   a. reactor volume
   b. reaction yield
8. Assess the logic of a choice of process
9. Investigate optimization problems and optimum temperature sequences

SUBJECT CE101 - ELECTRICAL AND ELECTRONIC ENGINEERING

(This syllabus is valid for examinations from March 2011)

SUMMARY

To provide candidates with a thorough understanding of the principles of electrical and electronic systems, including the analysis and performance of the circuits. Appreciation of electrical/electronic measuring systems and analogue/digital communication systems is also included.

AIM

To develop the candidate's

i. knowledge on ac and dc electrical principles relating to circuits, transformers and rotating machines
ii. skills in the design of sequential logic circuits
iii. knowledge in the use of measuring and instrumentation techniques

PREREQUISITE

Complex numbers, Boolean algebra.
Electrical properties of materials, conduction processes, semi conductors, pn junctions, simple diode and transistor characteristics, field effect transistors, magnetic materials.
Charge, voltage, current, resistance (Ohm Law), capacitance, inductance.
Passive dc circuits, Kirschoff's Laws.
Direct current, alternating current, elementary treatment of power, electrical generations and rectification.
Electric and magnetic fields and basic principles of electromagnetism.

LEARNING OUTCOMES

A candidate should be able to

(i) perform basic calculations on the performances of dc and ac circuits, transformers and rotating machines.

(ii) analyse the performance of diode circuits, transmitters and operational amplifier circuits.

(iii) design combinational and sequential logic circuits.

(iv) use measuring instruments and analyse instrumentation systems.

(v) outline A/D and D/A conversion and modulation.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   i. deductive and inferential reasoning
   ii. algebraic manipulation

3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Perform basic calculations on the performance of ac and dc circuits and equipment

The candidates are able to:

1. Analyse ac and dc single phase circuits
2. Recognise steady-state and transient responses in ac and dc circuits
3. Apply network theorems to ac and dc circuits
4. Undertake mesh and nodal analysis
5. Determine power and power factors
6. Determine resonance and Q-factor
7. Analyse balanced three-phase systems
8. Appraise the characteristics of transformers

Outcome 2 Analyse the performance of diode circuits, transmitters and operational amplifier circuits

The candidates are able to:

1. Employ diode circuits for
    a. rectification
    b. limiting
    c. clamping
2. Assess power supplies for
    a. smoothing
    b. regulation
3. Review transistor characteristics
4. Ascertain small-signal parameters
5. Develop amplifier circuit configurations
6. Determine
    a. current and voltage gain
    b. input and output impedances
    c. matching
7. Analyse feedback in amplifier circuits
8. Design and analyse operational amplifier circuits
    a. operational-amplifier characteristics
    b. operational-amplifier applications

9. Analyse oscillator circuits

Outcome 3 Design combinational and sequential logic circuits

The candidate knows how to:

1. design combinational and sequential logic circuits
2. recognise logic families
3. examine and appraise computer hardware components

Outcome 4 Use measuring instruments and analyse instrumentation systems.

The candidates are able to:

1. Select and use a variety of measuring instruments appropriate to
   a. single-phase ac circuits
   b. three-phase ac circuits
   c. dc circuits

2. Select a variety of measuring instruments appropriate to
   a. diode circuits
   b. transistor circuits

Outcome 5 Outline A/D and D/A conversion and modulation.

The candidates are able to:

1. Convert analogue instrumentation reading to digital signals
2. Convert digital signals to analogue readings
3. Operate and interpret communication systems to include
   a. amplitude modulation
   b. frequency modulation
   c. bandwidth, sidebands and power

SUBJECT CE102 – SOFTWARE AND INFORMATION SYSTEMS ENGINEERING

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content introduces the candidates to software engineering thereby providing a framework which will allow them to adopt a disciplined and database approach to the development, analysis and maintenance of a range of high quality software.

AIM

To equip the candidate with the knowledge and skills to monitor and measure aspects of the software process and to implement mechanisms leading to the development of high quality software by effective use of information systems.

PREREQUISITES

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LEARNING OUTCOMES

A candidate should be able to:

i. Describe, analyse, evaluate and use information systems

ii. Design and implement database systems

iii. Investigate, analyse and evaluate World Wide Web based information systems

iv. Explain the nature of software process and make selection of different approaches to its realisation in particular situations.

v. Validate, verify and manage software.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using IT skills over an extended period of time.
2. Monitor progress and adapt the candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving the use of IT for **two** different, complex purposes.
3. Evaluate the candidate's overall strategy and present the outcomes from the candidate's work using at least **one** presentation, showing integration of text, images and number.
4. Develop a strategy for using communication skills over an extended period of time.
5. Monitor progress and adapt the candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   • **one** group discussion about a complex subject;
   • **one** extended written communication about a complex subject.
6. Evaluate the candidate's overall strategy and present the outcomes from the candidate's work, using at least **one** formal oral presentation, including the use of two images to illustrate complex points.
7. Develop a strategy for using skills in problem solving over an extended period of time.
8. Monitor progress and adapt the candidate's strategy, as necessary, to achieve the quality of outcomes required when tackling **one** complex problem with at least three options.
9. Evaluate the candidate's overall strategy and present the outcomes from the candidate's work using a variety of methods.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Describe, analyse, evaluate and use information systems.

The candidates are able to:

1. Describe the range of scope of data used in information systems
    a. bibliographic/free text
    b. formatted text
    c. record oriented
    d. file based
    e. legacy data
2. Analyse and evaluate existing information systems
3. Investigate emerging developments in information systems
4. Extend existing information systems
5. Apply multimedia formats and their storage, and use transmission and compression techniques
6. Understand the ideas of data management and data mining and the concept of a data warehouse
7. Describe the role of a database administrator
8. Apply a multiuser relational database product including its
    a. data management
    b. application development techniques
9. Apply the use of Forms as a metaphor to the interface to an information system
10. Design a database user interface including
    a. menu design
    b. use of colour
    c. use of graphics
11. Assess programming Form activations using
    a. 4GL code
    b. embedded SQL
    c. event procedures
12. Use other programming techniques such as embedded SQL in C
    a. static
    b. dynamic

Outcome 2 Design and implement database systems.

The candidates are able to:

1. Understand the principles of database design and implementation
2. Apply methods for modelling information systems including diagramming conventions supported by

a. Yourdon/SSADM utilising data flow diagrams (DFD) to show
    i. process modelling
    ii. entity relationship (ER) diagrams
b. alternative process design techniques
    i. Unified Modelling Language (UML)

3. Compare and evaluate different approaches
4. Utilise relational modelling and data analysis
5. Understand functional dependency theory and normalisation
6. Apply Boyce Codd Normal Form rule to a relational data set
7. Undertake data modelling
    a. mapping an ER model to form a relational data set (Schema)
    b. coding a schema in SQL
8. Create indexes, keys and clusters
9. Apply entity and referential integrity
10. Compare the data centred approach with the file based approach
11. Assess data integrity and quality control
12. Understand transaction processing
13. Use a data dictionary
14. Discuss data independence and physical views of data
15. Compare and assess distributed information systems and database architectures
16. Understand relational calculus and algebra
17. Understand theoretical foundations of SQL
18. Assess SQL standards and be able to apply these standards for
    a. data definition
    b. views
    c. updates insertion of referential integrity constraints
19. Understand open SQL standard
20. Recognise the operators available in single and multiple (Join) table queries
21. Use embedded SQL

Outcome 3 Investigate, analyse and evaluate World Wide Web based information systems.

The candidates are able to:

1. Assess www based information systems
2. Undertake comparison of different client server achitectures
3. Apply www access to databases through techniques such as cgi scripts and html
4. Develop interactive graphical tools (applets) and the choice of tools for web enabled information processing
5. Undertake effective implementation, evaluation and testing of systems

Outcome 4 Explain the nature of software process and make selection of different approaches to its realisation in particular situations.

The candidates are able to:

1. Describe the Software Lifecycle.
2. Appraise the standard software life cycle model
    a. requirements
    b. specification
    c. architectural design
    d. detail design
    e. implementation and testing
    f. coding
    g. maintenance
3. Appraise alternative models
    a. spiral model
    b. prototyping model
    c. transformational model
4. Evaluate the strengths and weaknesses of the above approaches to life cycle modelling, particularly with reference to the object-oriented design paradigm
5. Explain the Software Process
6. Understand the concept of the software process
7. Appraise the SEI five level maturity model
8. Illustrate Software Specification
9. Explain the functional specification of software
10. Explain the non-functional specification of software
11. Describe requirements analysis and relationship with systems engineering and systems analysis and design

12 Appraise systems modelling

13 Discriminate between formal and informal approaches to describing specifications and their relative merits

14. Assess different approaches to formal specifications
    a. benefits
    b. drawbacks
15. Understand a common formal specification language, for example
    a. Z or
    b. VDM
16. Produce a specification of a simple system using a formal specification language
17. Demonstrate Software Design
18. Analyse software design
19. Identify characteristics of good design
20. Give example of different approaches to architectural design

21. Undertake a detailed study of each of the following approaches to software design
    a. object oriented
    b. data flow methods
    c. real-time methods
22. Identify CASE tools to support these activities
23. Interface Issues
24. Demonstrate understanding of the principles of interface design including the relative merits of
    a. graphical user interface systems
    b. command interfaces
25. Undertake user interface evaluation with respect to these principles
26. Describe tool support for interface design
27. Implementation Issues
    a. choice of programming language
    b. choice of programming project support environment
    c. selection of appropriate tools and factors influencing their choice
    d. understand
        i. strong typing
        ii. safe programming constructs
        iii. exceptions
        iv. fault tolerance
        v. information hiding to combat complexity
        vi. separate compilation
        vii. concurrency

Outcome 5 Validate, verify and manage software.

The candidates are able to:

1. a. validate and verify software by the use of
        i. terminology
        ii. reviews and walkthroughs
        iii. steps to be taken to ensure the effectiveness of approaches
    b. use validation and verification throughout the life cycle
    c. understand different approaches to testing, including
        i. black box or functional testing
        ii. white box or structural testing
        iii. path coverage
        iv. dynamic analysers
2. Undertake program verification using verification conditions and loop invariants in providing proofs of the correctness of simple programs that involve

a. assignment statements
b. conditional statements
c. simple while loops

3. Evaluate the strengths and weaknesses of different approaches to verification and validation.
4. Implement software management.
    a. Manage software by
        i. identifying its aims and purpose
        ii. planning and scheduling
        iii. risk identification and analysis
    b. Understand software re-engineering and re-use.
    c. Cope with change in all its forms:
        i. personnel
        ii. improvements and defect removal
        iii. requirements
        iv. specifications
        v. hardware
        vi. tools
        vii. environment
    d. Assess team selection methods and team building techniques
    e. Appreciate software engineering standards:
        i. coding
        ii. company specific
        iii. national and international
5. Understand the role and purpose of standards.
6. Understand software metrics and related tools to assist management.
7. Assess software cost estimation models including COCOMO.
8. Understand software quality assurance.
9. Assess the role of management in the review process.
10. Explain configuration management and version control
11. State the main activities involved in configuration management and version control
12. Use tools to support software engineering activities including
    a. make
    b. RCS
    c. SCCS
13. Apply a disciplined approach to the above activities based on the use of appropriate tools
    a. change control boards
    b. impact analysis
    c. appropriate statistics gathering
    d. release of changes

SUBJECT CK101 – CHEMISTRY FOR ENGINEERS

(This syllabus is valid for examinations from March 2011)

SUMMARY

The subject is about physical and organic chemistry fundamentals, applicable in industries where there are chemicals involved, and their production.

AIM

To provide the basic fundamentals of physical and organic chemistry in order to understand the chemical processes in the industry.

PREREQUISITIES

-

LEARNING OUTCOMES

A candidate should be able to:

(i) Describe the thermodynamic and physical principles of equilibrium in chemical processes

(ii) Explain the factors that influence the equilibrium and relate them to thermodynamic data

(iii) Classify hydrocarbon groups including the formation mechanism, chemical and physical properties

(iv) Explain the factors involved in the industrial production of important chemicals and petrochemicals

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

-

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome1 Describe the thermodynamic and physical principles of equilibrium in chemical processes

The candidates are able to:

1. Explain thermodynamic concepts
   a. reversible work
   b. free energy
   c. fugacity
   d. activity
2. Describe thermodynamic function
   a free energy function
   b Gibbs-Helmhotz equation
   c Gibbs-Duhem equation

3. Explain Raoult's and Henry's Law
4. Determine factors affecting the thermodynamic function

Outcome 2 Explain the factors that influence the equilibrium and relate them to thermodynamic data

The candidates are able to:

1. Determine chemical equilibrium, standard free energies, enthalpies and entropies
2. Explain equilibrium constant in gas and liquid phase reactions
3. Determine thermodynamic class trough experience.

Outcome 3 Classify hydrocarbon groups including the formation mechanism, chemical and physical properties

The candidates are able to:

1. Describe formation of compound from elements of C, H, O, N and other atoms
2. Recognize classes of compounds nomenclature and the main important reactions
   a. akanes
   b. alkenes
   c. alkynes
   d. aomatics
3. Recognize important functional group
   a. akyl halides
   b. alcohols
   c. ether
   d. adehydes
   e. ketone
   f. amine
   g. carboxylic acid
4. Determine the physical properties and chemical structures of classes of compound.

Outcome 4 Explain the factors involved in the industrial production of important chemicals and petrochemicals

The candidates are able to:

1. Describe industrial products of important chemical and petrochemicals
2. Identify mechanism of organic reaction
   a. radical and ionic reactions
   b. addition, substitution and elimination reactions
   c. substitution effects

SUBJECT CC101 – HYDRAULICS AND HYDROLOGY

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about the principles and processes involved in fluid mechanics, hydraulics and engineering hydrology.

AIM

This subject aims to develop understanding of flow situations in fluid mechanics and hydraulics and describe aspects of engineering hydrology. It also aims to identify problems and devise solutions.

PREREQUISITES

Refer to the General Guidelines.

LEARNING OUTCOMES

A candidate should be able to:

(i) Identify and process solutions for problems in fluid mechanics, pipe flow, rotodynamic machines and open channel flow

(ii) Describe aspects of engineering hydrology

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards skills and competencies in the following areas:

(i) Develop a strategy for using application of number skills over an extended period of time

(ii) Monitor progress and adapt a candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
  (a) deductive and inferential reasoning
  (b) algebraic manipulation

(iii) Evaluate a candidate's overall strategy and present the outcomes from the candidate's work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Identify and process solutions for problems in fluid mechanics, pipe flow, rotodynamic machines and open channel flow.

The candidates are able to:

1. determine fluid mechanics continuity and solve problems using Bernoulli's equation
2. assess fluid stream function and velocity potential function for a
   a. uniform stream
   b. source
   c. sink

d. doublet and point vortex
e. combinations of above

3. apply energy and momentum principles in the engineering context
4. assess free and forces vortex flow
5. determine laminar and turbulent flow
   a. boundary layers
   b. influence of surface roughness
6. analyse friction factors on flat plates
7. assess factors affecting
   a. boundary layer transition
   b. boundary layer separation and wake formation
8. investigate the drag force on single particles in fluids
9. calculate fluids
   a. drag coefficient
   b. Reynolds number
   c. terminal velocity
10. assess laminar flow between plates
11. assess steady flow in pipes
    a. pipe friction
    b. velocity distributions
    c. laminar and turbulent flows in
       i. smooth pipes
       ii. rough pipes
    d. Poiseuille's law
    e. Darcy's law
12. examine the relationship between friction factor, Reynolds number and relative roughness
13. examine local losses due to pipe friction
14. analyse pipe networks using interative methods
15. determine the reasons for unsteady pipe flow
    a. frictionless incompressible behaviour
    b. frictionless compressible behaviour
    c. surge tanks
16. describe the one – dimensional theory of
    a. pumps
    b. turbines
17. classify pumps and turbines
18. assess pump and turbine
    a. characteristics
    b. dimensionless parameters
    c. specific speed
    d. cavitation
19. select a pump for the range of pipe systems
20. assess steady flow in an open channel
    a. Chezy equations
    b. Manning equations
21. design non-erodible channels
22. recognise the effect of sediment transportation in open channels
23. analyse gradual varied non-uniform flow in channels
24. apply energy and momentum principles to rapidly varied flow in open channels
    a. hydraulic structures
    b. short channel transitions
    c. thin pipe weirs
    d. critical depth flow gauging structures
    e. hydraulic pump
25. investigate unsteady flow
    a. surges
    b. flood routing through channels
26. investigate the criteria, parameters and scales for physical models of
    a. rivers

b. coasts
c. harbours
d. hydraulic structures

27. ascertain the relative merits of physical and computational models

Outcome 2 Describe aspects of engineering hydrology

The candidates are able to:

1. describe and evaluate the hydrological cycle
   a. rainfall
   b. runoff
   c. unit hydrographs
2. discuss river gauging systems
3. analyse ground water flow
4. assess flood and drought forecasting
5. assess storage and flood control reservoir, mass curves and reservoir flood routing
6. discuss river training and restoration
7. discuss technique of groundwater extraction
8. analyse groundwater extraction
9. analyse sediment transport
10. analyse waves and currents
11. discuss shoreline coastal protection systems

SUBJECT DG201 –ENGINEERING MATERIALS II

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about the structure-mechanical property interrelationship of engineering materials and their predictive performance at the design.

AIM

To develop the candidate's knowledge of metals, polymers and ceramic materials and their properties.

PREREQUISITES

-

LEARNING OUTCOMES

The candidates will be able to:

i) Demonstrate understanding of the relationship between atomic bonding mechanisms and the physical properties of materials.
ii) Distinguish between microstructure and properties in three classes of materials.
iii) Discuss the interaction between the physical properties of materials and their behaviour during manufacture and in service
iv) Describe how the microstructure of a material can be controlled and modified to optimise performance during manufacture
v) Demonstrate the use of simple analytical techniques and model to predict the characteristics of materials.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

i) Develop a strategy for using communication skills over an extended period of time.
ii) Monitor progress and adapt student's strategy as necessary, to achieve the quality of outcomes required in the work involving:
    a. **One** group discussion about a complex subject
    b. **One** extended written communication about a complex subject.
iii) Evaluate student's strategy and present the outcomes from your work, using at least **One** formal oral presentation, including the use of two images to illustrate complex points.

ASSESMENT

A three-hour written examination.

CONTENT

Outcome 1 Demonstrate understanding of the relationship between atomic bonding mechanism and the physical properties of materials

The candidates are able to:

1. describe a materials solidifications under equilibrium conditions
2. describe the concepts of metallographic structures
3. interpret phases, phase diagrams and phase changes
4. recognise cast structures

5. explain departures from equilibrium conditions
6. describe the effects of thermo mechanical treatments on microstructure
7. explain the formation of polymer molecules by
    a. addition reactions
    b. condensation reactions
8. demonstrate the structure of
    a. thermoplastics
    b. thermosetting resins
    c. elastomers
9. explain the compounding of plastic and rubbers for manufacturer and service
10. conceptualise timber as a natural polymer
11. categorise ceramics and cements
    a. naturally occurring
    b. manufactured
12. relate atomic bonding mechanism to physical and mechanical properties

Outcome 2 Distinguish between microstructure and properties in three classes of materials

The candidates are able to:

Structural steels and cast iron

1. use the iron-carbon diagram to explain the effect on plain carbon steel of
    a. hardening
    b. tempering
    c. normalising
    d. stress relieving
    e. surface treatments
2. explain the relationship between microstructure and mechanical properties
3. describe the effects of alloying of steels on
    a. heat treatment response
    b. final properties
4. extend the iron carbon diagram to cast iron
5. explain the effects of non-equilibrium cooling on morphology and properties
6. determine the effect of alloying to produce stainless steel on
    a. structure
    b. corrosion resistance
7. explain carbide formation in stainless steel when joining by welding
8. explain stainless steel stabilisation to avoid carbide formation when welding

Non-ferrous alloys

9. ascertain the properties of cast and wrought aluminium alloys
10. select aluminium alloys to suit particular applications
    a. aeronautical
    b. ship and boat building
    c. lightweight structures
    d. automobile
11. describe heat treatment processes and their effect on properties
    a. age hardening
    b. precipitation treatment
    c. composition materials
12. assesses fibre reinforced plastics for properties and applications
13. explain reinforcing techniques and fibre-matrix reaction
14. assess current concrete and aggregates for properties and applications
    a. types and treatment
    b. chemical composition
15. determine the influence on hardening of cement and concrete of chemical admixtures
16. describe the properties of fresh concrete

a. setting process
b. hardening process

17. describe the properties of hardened concrete
    a. chemistry
    b. microstructure
    c. effect of curing
    d. strength
    e. creep
    f. shrinkage
    g. durability
18. conduct standard tests on concrete specimen
19. determine the mechanical properties of bitumen- aggregates mixes

Outcome 3 Discuss the interaction between the physical properties of materials and their behaviour during manufacture and in service

The candidates are able to**:**

1. Analyse the effect deformation processes on metals
    a. line and point defects
    b. effect of grain boundaries
    c. multiphase structures
2. assess the results of work hardening
3. describe the deformation characteristics of
    a. rolling
    b. extrusion
    c. forging
    d. deep drawing
4. describe the effects of deformation processes on mechanical properties
5. describe the effect of in service activity on materials
    a. fatigue
    b. creep
    c. tensile strength
6. explain the influence of bad design and accidental defects on the setting up of stress concentrations when in service
7. analyse fracture mechanic concepts
8. determine the origins of brittle behaviour in advanced ceramics
9. determine remedies for brittle behaviour in ceramics
10. assess corrosion prevention treatment techniques and treatments
11. explain how corrosion prevention treatments affect the microscopic structure of materials
12. Explain the degradation of polymeric materials in
    a. processing
    b. in service

Outcome 4 Describe how the microstructure of a material can be controlled and modified to optimise performance during manufacture

The candidates are able to

1. describe the casting of metals and metal alloys
    a. cast iron
    b. concast steel
    c. cast aluminium
2. analyse the structure of cast metals and the influence of casting conditions
3. describe casting mould design
4. recognise cast faults and soundness
    a. burning
    b. inclusions
    c. porosity

5. develop models of cast metal nucleation
6 analyse the effects of super-cooling on cast metal microstructures
7. describe powder technology in the production of advanced ceramics
8. the role of diffusion in the manufacture of advanced ceramics

Outcome 5 Demonstrate the use of simple analytical techniques and models to predict the characteristic of materials

The candidates are able to:

1 use model and use analytical techniques in support of outcomes 1 to 4

SUBJECT DG202 –MATHEMATICS

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content is about the application of advanced mathematical techniques by professional engineers.

AIM

To equip the candidate with the mathematical expertise as a tool for problem solving.

PREREQUISITES

Refer to General Guidelines.

LEARNING OUTCOMES

A candidate should be able to:

(i) Solve engineering problems using mathematical methods

(ii) Solve engineering problems using numerical methods.

(iii) Solve engineering problems using statistical methods.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:

    i. deductive and inferential reasoning
    ii. algebraic manipulation
3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

<u>Outcome 1</u> Solve engineering problems using mathematical methods.

The candidates are able to:

1. Express functions of 2 or 3 variables in terms of other variables
2. Find Taylor series expansions
3. Determine both constrained and unconstrained maxima and minima
4. Solve problems involving calculus
    a. Green's theorem
    b. Stokes theorem
    c. Gauss' theorem
    d. Employ vector calculus to simple applications

5. Apply simple applications from field theory
6. Solve problems involving complex variable theory
    a. analytic functions
    b. Cauchy-Riemann equations
    c. Poles, zeros and residues
    d. Conformal transformations
7. Apply Laplace transform methods to the solution of differential equations
    a. transfer functions
    b. convolution theorem
8. Apply Z-transform methods to the solution of difference equations and discrete systems
9. Solve second order partial differential equations by separation of variables including the use of Fourier series

Outcome 2 Solve engineering problems using numerical methods.

The candidates are able to:

1. Solve sets of linear equations
    a. Gauss-Seidel and Jacobi methods
    b. Matrix factorisation methods
2. Solve numerical optimisation problems
    a. direct search method
    b. simple gradient methods
3. Determine simple eigenvalues and eigenvectors
    a. direct and inverse iteration
    b. shift of origin
4. Solve simple systems of ordinary differential equations using eigenvalue analysis
5. Apply the above to vibration problems
6. Solve initial value problems for ordinary differential equations numerically
    a. Taylor series
    b. Runge-Kutta method
    c. Simple linear multi-step methods
    d. Convergence and stability
    e. Coupled ordinary differential equations
7. Solve boundary value problems for ordinary differential equations numerically
    a. shooting and finite difference methods
    b. simple eigenvalue problems
8. Use simple finite difference methods to solve partial differential equations
9. Solve initial value problems for partial differential equations numerically
    a. explicit and implicit procedures
    b. simple ideas on errors and stability
10. Solve boundary value problems for partial differential equations numerically
    a. direct solution of finite difference equations
    b. iterative solution of finite difference equations

Outcome 3 Solve engineering problems using statistical methods.

The candidates are able to:

1. Solve problems using Binomial, Poisson and Normal distribution to include
    a. probability of defects in production
    b. errors in observation

2. Test samples to make statistical decisions
    a. χ^2
    b. t-tests
    c. regression

3. Use Markov chains

4. Apply the above to queuing theory.

SUBJECT DC201 – FLUID MECHANICS

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is concerned with the properties of fluids and the principles of fluid mechanics. Additionally, it covers fluid systems analysis, performance studies and the application of systems design.

AIM

To develop understanding and analytic skills in fluid mechanics and the application of these to simple fluid systems.

PREREQUISITES

-

LEARNING OUTCOMES

The candidates will be able to:

(i) Understand basic fluid mechanics.
(ii) Understand fluid flow and perform fluid flow calculation
(iii) Analyse the mechanics of particles immersed in a fluid
(iv) Analyse the principle and applications of turbo-machinery

SKILS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving :
   a deductive and inferential reasoning
   b algebraic manipulation
3. Evaluate candidate's and present the outcomes from candidate's work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Understand basic fluid mechanics related to compressible and incompressible fluids

The candidates are able to:

1. define compressible and incompressible fluids
2. derive and solve conservation equation for
   a. continuity
   b. momentum
   c. energy
   and any combination of these
3. apply conservation equations to engineering systems
4. describe the kinematics of fluid motion in terms of
   a. streamlines
   b. stream tubes
   c. particle paths
   d. streak lines

5. define
   a. irrotational and rotational flows
   b. circulation
   c. vorticity
6. develop stress-strain relations for
   a. Newtonian fluids
   b. Non-Newtonian Fluids

7. determine and apply geometric, kinematics and dynamic similarity conditions in fluid systems
8. solve problems using
   a. Buckingham II theorem
   b. dimensional analysis
9. derive the principal dimensionless parameters of fluid flows
   a. Reynolds number
   b. Froude number
   c . Mach number
   d. pressure number
   e. roughness ration

   and perform calculations involving these

Outcome 2 Understand fluid flow and perform fluid flow calculations

The candidates are able to:

1. Solve compressible fluid problems involving
   a. speed of weak pressure waves
   b. stagnation pressure
   c. fluid density
   d. fluid density
2. Solve problems involving isentropic flow of a perfect gas in ducts cross-sectional area in terms of Mach number and including choked flow
3. Describe the formation of a normal shock in convergent-divergent nozzles
4. Determine and apply laminar flow in pipes and on between flat plates
5. Calculate the velocity distribution in laminar flow
6. Calculate the volumetric flow rate in laminar flow
7. Apply laminar flow to hydrodynamic lubrication
8. Analyse laminar flow using
   a. boundary layer theory
   b. displacement and momentum thickness
   c. skin friction coefficient
9. Solve problems using the momentum intergral equation
10. Calculate the drag on the flat plate in laminar flow
11. Decsribe the factors affecting boundary layer transition
12. Analyse turbulent boundary layers in terms of
    a. power law
    b. logarithm velocity distribution
    c. laminar sub layer
    d. skin friction on a flat plate
13. Calculate the drag on a flat plate in turbulent flow
14. Determine and apply the effects of surface roughness on fluid flow
15. Describe boundary layer separation and the formation of wakes
16. Solve problems involving steady flow in pipes of
    a. Newtonian fluids
    b. non-Newtonian fluids
17. Analyse the relationship in steady flow between friction factor, Reynolds number and relative roughness
18. Analyse simple pipe networks using interative calculations
19. Apply Euler and Bernoulli equations to imcompressible inviscid fluid flows
20. Determine and apply the stream function and velocity potential function in steady two-dimensional flows
21. Determine and apply flows of imcompressible fluids resulting from simple combinations of a

a. uniform stream
b. source
c. sink
d. doublet
e. point vortex

22. Determine and apply inviscid flow around a circular cylinder with circulation including the calculation of
    a. pressure distribution
    b. lift force

Outcome 3 Analyse the mechanics of particles immersed in a fluid

The candidates are able to:

1. Analyse the behaviour of single particles in a fluid in terms of
    a. Stokes Law for spherical particles
    b. drag coefficient
    c. Reynolds number effects
    d. terminal velocity
2. Investigate particles in fluid systems forming
    a. sedimentation of uniform size
    b. sedimentation of varying size range
3 analyse flow in packed beds using
    a. Darcy's law
    b. Carmen-Kozeny equation

Outcome 4 Analyse the principles and application of turbo machinery

The candidates are able to:

1. Use one dimensional theory to analyse the performance of
    a. turbines
    b. pumps
    c. fans
2. Assess axial and centrifugal flow machines
3. Apply dynamic similarity to turbo-machines in terms of
    a. flow,head and power coefficients
    b. specific speed
    c. characteristic performance curves
    d. net positive-suction head (NPSH)
4. Analyse turbo-machinery systems in terms of
    a. system load line
    b. pump and turbine operating conditions

SUBJECT DC202 – MECHANICS OF SOLIDS

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about elastic behaviour of engineering components and using theoretical, numerical and experimental techniques to determine stresses, strain and deflections under various load.

AIM

To give students a thorough grounding in elastic behaviour and an introduction to non elastic behaviour of engineering components using classical theory, approximate numerical methods and experimental techniques.

PREREQUISITES

-

LEARNING OUTCOMES

The candidate will be able to:

i) Calculate stresses, strain and deflections in a range of components under various load conditions
ii) Select appropriate method for the detail design of components
iii) Demonstrate an understanding of the basis of computer software used in stress analysis

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   a Deductive and inferential reasoning
   b Algebraic manipulation
3. Evaluate candidate's overall strategy and present the outcomes from candidates work, including use of charts, diagrams and graphs to illustrate complex data.
4. Develop a strategy for using IT skills over an extended period of time.
5. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving the use of IT for two different, complex purposes.
6. Evaluate candidate's overall strategy and present the outcomes from candidate's using at least **one** presentation, showing intergration of text, images and number.

ASSESSMENT

A three-hour written examination.

CONTENT

<u>Outcome 1</u> Calculate stresses, strain and deflections in a range of components under various load conditions

The candidates are able to :

1. Use Mohr's Circle to determine
   a. stresses on inclined planes
   b. combined bending torsion and axial loading
2. Use and position on components strain gauge rosettes
3. Use calculations and or graphic means to determine
   a. shear force and bending moments in laterally loaded beams

b. bending stress and shear stress distribution in beams
c. deflection of beams
d. solution of statically indeterminate beams
e. centre of shear in beams

4. Extend shear force,bending moment,bending stress, shear stress and
   a. deflection analysis to
   b. beams of asymmetric cross section
   c. composite beams
   d. beams of “elastic-perfectly plastic” material
5. Determine shear stress and twist of
   a. circular solid sections
   b. thin wallet cylinders
   c. simple open sections
6. Apply Euler critical loads to determine buckling for a combination of
   a. free conditions
   b. pinned conditions
   c. built in end conditions
7. Determine limiting stress condition
8. Use analytical methods to determine stresses and displacements in ring,cylinders and discs under axi-symmetric loading
   a. internal/external pressure
   b. shrink fits
   c. rotations
9. Apply Lame equations to problem solving
10. Employ finite element analysis
    a. discretisation
    b. types of elements
    c. relationship between
       i. nodal forces
       ii. nodal displacement
       iii. stiffness matrix
11. Represent examples of linear elements using springs
12. Obtain stiffness matrix using
    a. one-dimensional quadratic elements
    b. displacement functions
    c. shape functions
    d. principle of virtual work
13. Determine stresses from primary unknown nodal displacements
14. Understand the underlying assumptions and approximate nature of the results of Finite Element Method
15. Analyse engineering materials behaviour when loadings and services conditions
    a. involve
    b. fatigue
    c. yield criteria
    d. fracture mechanics
    e. creep
    f. viscoelastically
16. Asses and select materials for applications
    a. plastics
    b. composites
    c. ceramics
    d. modern materials

<u>Outcome 2</u> Select appropriate methods for the detail design of components

The candidates are able to

1. Implement the analytic techniques in Outcome 1 to engineering designs involving
   a. beams
   b. columns

c. thin cylinder applications
d. pressure vessels
e. structural steelwork
f. shafts
g. buildings

Outcome 3 Demonstrate an understanding of the basis of computer software used in stress analysis

The candidates are able to:

1. undertake and solve engineering design calculations and mechanics of materials problems using various computer software packages

SUBJECT DC203 – STRUCTURAL ANALYSIS

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about the deformity of structures and the principles of elastic and plastic analysis of simple structures.

AIM

This subject aims to equip the candidate with the techniques to analyse structures under various loading conditions. Internal stresses and forces are analysed to determine design specifications and avoid collapse or serious deformation.

PREREQUISITES

Refer to the General Guidelines.

LEARNING OUTCOMES

A student should be able to:

(i) undertake elastic analysis of structures

(ii) undertake plastic analysis of structures

(iii) understand stability and instability of elements and structures

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards skills and competencies in the following areas:

1. Develop a strategy for using the application of number skills over an extended period of time
2. Monitor progress and adapt a candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   (a) deductive and inferential reasoning;
   (b) algebraic manipulation
3. Evaluate a candidate's overall strategy and present the outcomes from the candidate's work, including use of text, images, number, charts, diagrams and graphs to illustrate complex data.
4. Develop a strategy for using IT skills over an extended period of time.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Undertake elastic analysis of structures.

The candidates are able to:

1. define and determine strain energy
2. apply the principle of virtual work
3. use virtual forces in obtaining displacements
4. use virtual displacements in obtaining equilibrium equations

5. apply the principle of minimum potential energy
6. analyse statically determinate and/or statically indeterminate structures
    a. calculation of forces for
    b. calculation of displacements for
    c. generation of influence lines for
        i. pin-jointed trusses
        ii. beams
        iii. rigid jointed frames
7. determine statical and kinematical indeterminacy of structures
8. apply the force method and the displacement method (including slope deflection and moment distribution), taking account of effect of temperature and lack of fit

Outcome 2 Undertake plastic analysis of structures

The candidates are able to:

1. analyse steel frames and beams using static and mechanism methods for plastic collapse.
2. use plastic analysis techniques for reinforced concrete slabs
    a. upper bound method (yield-line theory)
    b. lower bound method (strip theory)

Outcome 3 Understand stability and instability of elements and structures

The candidates are able to:

1. investigate the general principles and criteria of elastic instability
2. assess struts and frames for instability
3. use Euler load for pin-ended struts and effect of other end conditions
4. investigate the effect on structures /beams / columns of
    a. initial curvature
    b. lateral loads
    c. eccentric loads
5. describe lateral torsional buckling of beams

SUBJECT DC203– STRUCTURAL DESIGN

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about the structural action of common building materials as well as the development of an engineer's ability to use computational and calculation methods to determine loads and forces from first principles. It also includes the relevant codes of practice for Steelwork, Concrete, Timber and Masonry.

AIM

This subject is to develop the candidate's ability to investigate the behaviour of steelwork, reinforced concrete, timber and masonry in buildings and bridges.

PREREQUISITES

Refer to the General Guidelines.

LEARNING OUTCOMES

A student should be able to:

(i) demonstrate the understanding of the behaviour of steelwork elements, their support and connections in buildings and bridges

(ii) design and detail reinforced concrete elements in buildings and bridges

(iii) design and detail structural masonry and timber elements in buildings

(iv) use the relevant code of practice

LEARNING HOURS

It is recommended that 300 hours be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using skills in problem solving over an extended period of time
2. Monitor progress and adapt a candidate's strategy, as necessary, to achieve the quality of outcomes required when tackling **one** complex problem with at least three options
3. Evaluate a candidate's overall strategy and present the outcomes from the candidate's work using a variety of methods.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Demonstrate understanding of the behaviour of steelwork elements, their support and connections in buildings and bridges.

The candidates are able to:

1. use design techniques for structural steel elements in simple
   a. frames and trusses
   b. stanchions – subjected to axial and bending
   c. beams
   d. crane girders
   e. lattice gantry columns - – subjected to axial and bending
   f plate girders
   g hollow section truss members

2. use elastic and plastic design techniques for rigid portal frames
3. design connections in steel frames
   a. brackets
   b. haunches
   c. column splices
   d. base-plates
4. produce designs of composite floor beams including checks on pull-out shear studs

Outcome 2 Design and detail reinforced concrete elements in buildings and bridges

The candidates are able to:

1. design in-situ and pre-cast concrete elements
   a. simply supported and continuous beams of
      i. rectangular section
      ii. T section
      iii. L section
   b. singly and doubly reinforced beam sections
   c. slabs
      i. two-way spanning
      ii. one-way spanning
   d. solid and ribbed slabs
   e. columns subject to axial and moment loading
2. assess the use of sub-frames in frame analysis
3. design crank members in staircases
4. design combined and balanced foundations
5. assess the principles and design of simply supported pre-stressed concrete beams

Outcome 3 Design and detail structural masonry and timber elements in buildings

The candidates are able to:

1. produce design for load-bearing brickwork and blockwork for vertical loading
2. assess the design of masonry panels for lateral loading
3. assess the design of industrial sheds
   a. reinforced brickwork
   b. reinforced cavity retaining walls

c. pierced walls

4. design solid timber sections as
   a. beams
   b. columns
5. assess the design of
   a. built-up members
   b. glued-laminated members
   c. timber truss design
6. assess structural timber applied to
   a. formwork
   b. falsework

Outcome 4 Use the relevant codes of practice

The candidates are able to:

1. use codes of practice to aid design
2. extract information from codes of practice
3. check designs and design calculations against codes of practice

SUBJECT DC205 - GEOTECHNICAL ENGINEERING

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about the geotechnical conditions which effect the design of load bearing foundations and earth retaining structures. It also includes geotechnical engineering studies which involved in the conservation, preservation and protection of existing structures as well as solving environmental engineering problems.

AIM

This subject aims to provide a thorough understanding of the behaviour of soil and rocks and the interaction between the ground and the structures founded on it. It also aims at solving environmental engineering problems.

PREREQUISITES

Refer to the General Guidelines.

LEARNING OUTCOMES

A candidate should be able to

(i) create and interpret simple engineering geological models in plan and cross sectional drawings

(ii) analyse soil and rock behaviour and understand the process of ground investigations

(iii) undertake soil analysis methods

(iv) investigate stress states in natural and man made situations

(v) determine appropriate foundation and earth retaining structure system

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards skills and competencies in the following areas:

1. Develop a strategy for using skills in problem solving over an extended period of time
2. Monitor progress and adapt a candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   (a) deductive and inferential reasoning;
   (b) algebraic manipulation
3. Evaluate a candidate's overall strategy and present the outcomes from the candidate's work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Create and interpret simple engineering geological models in plan and cross sectional drawings.

The candidates are able to:

1. read and interpret a geological map including
   a. constructing structural contours (strike lines)
   b. drawing the position of outcrops and intersections of strata with proposed engineering works
   c. drawing cross sections depicting geological sequences and structure
   d. identifying geotechnical settings and the modes of failure to which they might give rise

2. classify acquifers and predict the behaviour of ground water in excavations
   a. confined acquifer (water table or phreatic surface)
   b. unconfined acquifer (piezometric surface, artesian conditions)

Outcome 2 Analyse soil and rock behaviour and understand the process of ground investigations.

The candidates are able to:

1. assess the features of rocks as an engineering material
   a . types of rock
   b. constituents of various rocks
   c. classification
   d. folds and faults
2. review the engineering behaviour of principle rock types
3. undertake testing methods appropriate to rock types
4. analyse rock masses
   a. description
   b. classification
   c. behaviour
5. undertake rock masses mapping
6. implement discontinuity analysis
   a. translational failures
   b. toppling failures
   c. rotational failures
7. analyse rock bolting and anchor designs
8. describe the principle methods of excavations
9. analyse rock support systems during excavations
10. undertake site and ground investigation
    a. planning procedures
    b. methods
    c. producing reports

Outcome 3 Undertake soil analysis methods.

The candidates are able to:

1. describe and classify soils
   a. physical properties
   b. phase relations
   c. index properties
   d. particle size distributions
   e. mineralogy
2. analyse problems based on total and effective stress concept
3. investigate the strength and deformation characteristics of soils
   a. triaxial tests

b. Mohr-Coulomb analysis
c. stress path analysis
d. stiffness at small strain

4. conduct stress analysis within a soil mass and determine pressure distribution due to foundation loads
5. assess the effect of settlement of granular soils
6. analyse the settlement of granular soils
7. investigate the settlement of clays
   a. immediate
   b. consolidation
   c. secondary settlement
8. investigate the rates of settlement of clays
9. investigate the effects of vertical drains on settlement

Outcome 4 Investigate stress states in natural and man made situations.

The candidates are able to:

1. analyse lateral earth pressures and stress states in natural and man made situations
   a. banks
   b. retaining walls
   c. piling

2. analyse the effects of pore water pressures and uniform surcharges
3. design earth retaining walls
4. assess the effectiveness of cantilever and anchored sheet pile walls
5. assess the effectiveness of ground anchors
6. use graphical and mathematical techniques to solve problems involving water flow in soils
7. investigate soil compressibility
   a. fundamentals of consolidation
   b. normal and over-consolidated soils
   c. pre-consolidation pressure
   d. primary and secondary consolidation
8. solve consolidation settlement problems using calculations
9. conduct soil tests
   a. laboratory
   b. insitu
10. investigate soil slopes
    a. principle concept
    b. methods of analysis
    c. effects of water

Outcome 5 Determine appropriate foundation and earth retaining structure systems

The candidates are able to:

1. determine the bearing capacity of foundations
   a. shallow
   b. deep
2. determine foundation types
   a. pads
   b. rafts
   c. buoyant
   d. basements
   e. piled
   f. strip
3. determine ultimate and allowable bearing capacities of types of foundations
4. analyse problems associated with foundation deformations and its effect on buildings
5. undertake geotechnical analysis of foundations

6. determine necessary ground treatments
    a. drainage and dewatering
    b. exclusion techniques
    c. soil stabilisation/modification
    d. cement and lime stabilisation
    e. reinforcement
    f. geotextiles
7. determine field applications and equipments for ground treatments
8. assess the need for grout and grouting of rocks and soils
9. identify the environmental aspects of geotechnical processes

SUBJECT DC206 – SURVEYING

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about the fundamental survey techniques required for civil engineering applications including roads, railways and tunnels. It also provides understanding and the capability to handle surveying instruments such as theodolite, totalstation and GPS Engineering surveying instrumentations.

AIM

This subject aims to develop understanding and techniques of modern surveying procedures and to appreciate the importance of "setting out" in construction.

PREREQUISITES

Refer to the General Guidelines.

LEARNING OUTCOMES

A candidate should be able to:

i) apply uncertainty and quality assessment

ii) carry out survey

iii) manage data

iv) apply survey methods to industrial applications

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards skills and competencies in the following areas:

1. Develop a strategy for using skills in problem solving over an extended period of time
2. Monitor progress and adapt a candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   i. deductive and inferential reasoning;
   ii. algebraic manipulation
3. Evaluate a candidate's overall strategy and present the outcomes from the candidate's work, including use of charts, diagrams and graphs to illustrate complex data.
4. Develop a strategy for using skills in working with others over an extended period of time.

ASSESSMENT

By a three-hour written examination.

CONTENT

<u>Outcome 1</u> Apply uncertainty and quality assessment

The candidates are able to:

1. explain the meaning and purpose of engineering survey
2. explain measurements and its principles
3. recognise errors in measurements
4. demonstrate ability to undertake surveys
5. establish precision and accuracy limits
6. eliminate mistakes and systematic errors in measurements
7. recognise random errors and explain the general laws of probability
8. weight and adjust measurements

Outcome 2 Carry out survey

The candidates are able to:

1. describe angle measurement using theodolite
    a. set-up and adjustment
    b. measure, book, abstract and set-out
        i. horizontal angles
        ii. vertical angles
2. identify errors in angular measurements
3. identify the effects of miscentering on horizontal angles
4. describe the most suitable instrument
5. describe the use of electronic total station instruments
6. explain the fundamental principles of levelling
    a. test and adjust levelling instruments
    b. sources of error
    c. levelling techniques
    d. calculation of reduced level
        i. rise and fall
        ii. height of collimation
    e. inverted staff reading
    f. sectional and contour levelling
    g. reciprocal levelling
    h. trigonometrical levelling
    i. earth curvature and refraction\
    j. acceptable limits of errors in levelling
    k. digital levels
    l. precise levelling
7. describe distance measurement by taping and electromagnetic methods
    a. fundamental Electronic Distance Measurement (EDM) theory
        i. errors
        ii. calibration
    b. correction and reduction of measured distances to National Grid distance
8. appraise developments in EDM
9. use the principles of photogrammetry in surveying
10. interpolate measurements from aerial photographs
11. assess stereoscopic viewing and parallax
12. describe Global Positioning Systems (GPS) in Surveying
    a. user, space and control segments
    b. overviews of the applications of
        i. signals and codes
        ii. static and kinematic applications of GPS
        iii. real time and post processed solutions

13. appraise recent developments in GNSS engineering surveying instrumentation and techniques, including laser scanning

Outcome 3 Manage data

The candidates are able to:

1. handle data involving
   a. angles
   b. bearings
   c. co-ordinates
2. produce computations involving National Grid rectangular co-ordinates
3. define True North and Grid North
4. determine local scale factors, convergence of meridians and other parameters by
   a. approximations
   b. precise methods
5. correlate both surface and underground surveys to the National Grid
6. make Bowditch adjustment of traverses
7. appraise engineering survey networks

Outcome 4 Apply survey methods to industrial applications

The candidates are able to:

1. describe implementation on dimension of control in engineering constructions by setting out horizontal, transition and vertical curves
   a. on the surface
   b. in tunnelling
2. select suitable equipment for construction surveys
3. apply horizontal and vertical control
4. describe setting out for
   a. roads
   b. buildings
   c. pipelines
5. identify sources of error in survey
6. describe monitoring of deformation and subsidence
7. describe survey for tunnel construction
   a. direction control
   b. gyro-theodolite observations and computations
   c. laser instruments for alignment and setting out
8. determine areas from plan measurements by
   a. co-ordinates
   b. cross-sections
9. use general volume and earthwork formulae
10. construct and use mass-haul diagrams

SUBJECT DC207 – HIGHWAY AND TRANSPORTATION

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about the fundamental survey techniques required for civil engineering applications including roads, railways and tunnels. It also provides understanding of the traffic and highway engineering for road and highway designs. The subject also deliberates materials used in highway construction.

AIM

This subject aims to develop understanding of the traffic and highway engineering for road and highway designs.

PREREQUISITES

Refer to the General Guidelines.

LEARNING OUTCOMES

A candidate should be able to:

(i) discuss the traffic data collective methods for use in road and highway design

(ii) design main components of roads and highway systems

(iii) determine level of service and highway capacity

(iv) design pavement and gravel roads using different methods

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards skills and competencies in the following areas:

1. Develop a strategy for using skills in problem solving over an extended period of time
2. Monitor progress and adapt a candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   i. deductive and inferential reasoning;
   ii. algebraic manipulation
3. Evaluate a candidate's overall strategy and present the outcomes from the candidate's work, including use of charts, diagrams and graphs to illustrate complex data.
4. Develop a strategy for using skills in working with others over an extended period of time.

ASSESSMENT

By a three-hour written examination.

CONTENT

Outcome 1 Discuss the traffic data collective methods for use in road and highway design

The candidates are able to:

1. Discuss the traffic data collective methods for use in road and highway design

a. Theories of flow
b. design priority type
c. round-about
d. signalised junctions

Outcome 2 Design main components of roads and highway systems

The candidates are able to:

1. Design main components of roads and highway systems
   a. Roads and highway systems
   b. traffic characteristics
   c. locations and earthworks operations

Outcome 7 Determine level of service and highway capacity

The candidates are able to:

1. Determine level of service and highway capacity
   a. Design of roads and highways
   b. highway capacity
   c. junctions and interchangers

Outcome 3 Design pavement and gravel roads using different methods

The candidates are able to:
1. Design pavement and gravel roads using different methods

   a. Design of road pavement
   b. pavement materials
   c. pavement management systems
   d. distress and evaluation of pavement
   e. Drainage system for highways
   f. erosion control and gravel roads.

SUBJECT DE201 – ELECTRICAL CIRCUITS AND FIELDS

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content is about two fundamental topics in electrical engineering, fields and circuits.

AIM

To develop an understanding of fields and circuits and to use it to solve problems in electrical engineering.

PREREQUISITE

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LEARNING OUTCOMES

A candidate should be able to:

(i) Solve problems involving circuit theory

(ii) Solve problems involving field theory

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   i. deductive and inferential reasoning
   ii. algebraic manipulation
3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Solve problems involving field theory

The candidates are able to:

1. Use Laplace's equation to determine potential distribution in two dimensions for simple geometric shapes of conducting boundaries.
2. Apply image methods to the above
3. Use Gauss' theorem for electrical flux density calculations for
   a. isotropic dielectric media
   b. composite dielectric media
4. Calculate D and E
5. Calculate capacitance of configurations with two or more conductors
   a. parallel plate capacitor
   b. concentric cylinders
   c. parallel wires

d. wire and parallel plate

6. Determine dielectric polarisation and energy density
7. Produce and measure magnetic fields
8. Assess the properties and characteristics of magnetic materials
9. Assess magnetic losses with alternating excitation
10. Determine magnetic potential and magnetomotive force
    a. Biot-Savart and Ampere laws for calculating B and H in fields produced by conductor and coil configurations
    b. Calculations for coil arrangements to produce magnetic fields between poles faces
    c. Flux leakage
    d. Fringing

11. Determine electromagnetic induction by calculation of self-inductance and mutual induction for simple configurations
    a. co-axial cable
    b. transmission line

12. Determine mechanical force and torque relations for conductor shapes in magnetic and electrical fields
13. Assess electromagnetic skin effect

Outcome 2 Solve problems involving circuit theory.

The candidates are able to:

1. Assess time-domain response
2. Analyse lumped-parameter networks excitations
    a. impulse
    b. step
    c. ramp
    d. sine wave
    e. others
3. Determine steady-state and transient responses
4. Evaluate the response from poles and zeroes
5. Apply superposition theorem and convolution
6. Use locus diagrams
7. Use Fourier series and Fourier transforms power spectra and spectral analysis of simple waveforms
8. Systematic formulate network equations in linear dc and ac circuits
    a. nodal
    b. mesh
9. Manipulate two port parameters in two-port networks
10. Apply the above to filter circuits and networks
    a. transformers
    b. T-networks
    c. II-networks
    d. Ladder networks
11. Analyse the relationships of the above

SUBJECT DE202 – ELECTRICAL MACHINES AND DRIVES

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content is about the principles involved in electrical machines and machine drives including power electronics.

AIM

To facilitate an understanding of dc machines, induction machines and various drives and includes the development of knowledge of energy conversion, operational parameters and characteristics.

PREREQUISITE

-

LEARNING OUTCOMES

A candidate should be able to:

(i) Appreciate electrical machine fundamentals.

(ii) Illustrate dc, induction, stepper and reluctance machines.

(iii) Outline general issues common to all drive systems.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards the key skills in the following areas:

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   i. deductive and inferential reasoning
   ii. algebraic manipulation
3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written paper.

CONTENT

<u>Outcome 1</u> Appreciate electrical machine fundamentals.

The candidates are able to:

1. Determine force on current-carrying conductors
   a. Faraday's law

b. Motional electro-motive force (emf)

2. Investigate electrical machines
   a. concentrated windings
   b. magneto-motive force (mmf)
   c. working and leakage flux
   d. flux density and mmf distributions
      i. smooth air gap case
      ii. harmonic mmf
   e. magnetic and electric loading and relation to machine volume

3. Investigate machine rating
   a. losses
   b. cooling
   c. temperature rise
   d. case style

Outcome 2 Illustrate dc, induction, stepper and reluctance machines.

The candidates are able to:

1. Analyse steady-state performance of dc machines and use relevant equations
   a. equivalent circuits
   b. characteristics of machines
      i. separately-excited
      ii. shunt
      iii. series
2. Determine the transient performance of dc machines
   a. with armature inductance
   b. without armature inductance

3. Investigate universal dc machines (ac series commutator)
4. Assess the operation of dc machines with a chopper and with field weakening
5. Investigate dc wound field and permanent magnet excitation
6. Analyse the construction, operation and control of brushless dc machines
7. Assess steady-state performance of induction machines and use relevant
   a. equations
   b. equivalent circuits
   c. phasor diagrams
8. Understand the characteristics and constructional features of cage-rotor induction machines in
   a. three-phase form
   b. single-phase form
   (including capacitator-fed auxiliary winding configuration)

9. Determine torque/speed relationship of induction machines
   a. fixed supply
   b. variable voltage supply
   c. variable frequency supply
10. Analyse open-loop variable speed operation and closed-loop controlled slip operation in induction machines to include
    a. control block diagrams
    b. V/f relationship
11. Assess basic torque production mechanisms for stepper machines
    a. reluctance effect machines
    b. permanent magnet machines
12. Determine the relationship between machine features and step angle
13. Investigate the circuits required for current pulse control
14. Analyse commutation sequences and control for stepper and reluctance machines

Outcome 3 Outline general issues common to all drive systems

The candidates are able to:

1. Use equations of motion for rotary dynamic drive systems
2. Determine speed/time relationships for drives
3. Determine the relevance to acceleration of length to radius ration of machines
4. Produce speed and torque curves including
   a. regeneration
   b. reverse rotation regions
5. Assess torque, speed and position controlled drives
6. Develop an awareness of drive requirements for the common application of electrical drives such as
   a. machine tools
   b. transport
   c. lifts
7. Develop an awareness of speed, current and torque transducers
8. Investigate high-current and high-voltage device
   a. characteristics (ratings, gate drives and switching characteristics) of
      i. diodes
      ii. thyristors including the GTO thyristor
      iii. semiconductor field effect thyristor (MOSFET)
      iv. insulated gate bipolar transistors (IGBT)
   b. conduction and switching power losses

9. Investigate circuits relevant to supplying electrical machines
   a. dc to dc
   b. dc to ac power conversions
   c. ac to dc power conversions
10. Assess limits placed on machine operation by converters including regeneration constraints
11. Understand the pulse-width-modulation (PWM) of switching wave forms

SUBJECT DE203 – ELECTRICAL POWER SYSTEMS

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content is about understanding the analysis and design of the generation, transmission, distribution and supply of electrical energy in a contemporary industrial society.

AIM

To develop the candidate's knowledge of electrical generation, 3 phase systems of transmission and distribution and the environmental impact of electrical energy systems.

PREREQUISITE

-

LEARNING OUTCOMES

A candidate should be able to:

(i) Assess energy conversion, economics and environment

(ii) Understand power generation.

(iii) Describe transmission and distribution systems

(iv) Analyse systems and understand system operations

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

This subject contributes towards the key skills in the following areas:

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   i. deductive and inferential reasoning
   ii. algebraic manipulation
3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

<u>Outcome 1</u> Assess energy conversion, economics and environment.

The candidates are able to:

1. Describe methods of producing electrical energy using fossil fuel
   a. coal

b. diesel
c. gas

2. Assess the cost of fossil fuel usage for generating electricity
3. Describe energy conversion in electrical energy generation
   a. wind
   b. solar
   c. wave
   d. hydro

4. Describe oil, gas and steam turbines
5. Describe and assess
   a. system loads
   b. loss factors'
   c. tariffs (capacity and energy charges)
   d. load management
   e. forecasting

6. Describe system layout including interconnection for
   a. security
   b. transfer across territorial boundaries
   c. rental distribution
   d. dominant costs and restraints

Outcome 2 Understand power generation.

The candidates are able to:

1. Identify types of synchronous generators
   a. cylindrical rotor
   b. salient pole
2. Describe the parameters and operating characteristics of synchronous generators
3. Calculate and assess short circuit performance
4. Describe parallel operation with single control by
   a. governors
   b. automatic voltage regulators (AVR's)
5. Explain an operating chart and its derivation including
   a. stability limits
   b. rating limits
6. Ensure electrical earthing arrangements are adequate

Outcome 3 Describe transmission and distribution systems

The candidates are able to:

1. Describe power transformers
   a. types of construction
   b. parameters
   c. testing connection (delta/star)
   d. use of tap-changers
   e. sequence impedances
2. Describe overhead lines
   a. construction
   b. parameters
      i. short equivalent circuits
      ii. medium equivalent circuits
      iii. long equivalent circuits
   c. voltage stress calculations
   d. conductors

e. natural load
f. need for compensation

3. Describe types of cables for transmission circuits
    a. operational parameters
    b. insulation
    c. need for compensation
4. Describe substation components
    a. switchgear operating principles of main types
        i. gas
        ii. airblast
        iii. oil
        iv. vacuum
    b. breaking and making capacity
        i. asymmetrical
        ii. symmetrical
5. Describe substation layouts and types
6. Describe instrumentation transformers and transducers
7. Recognise the need for surge diverters
8. Appreciate high voltage direct current transmission
    a. characteristics
    b. economics
    c. converter operation
9. Assess the design of distribution systems for reliability and economic operation in
    a. urban areas
    b. rural areas
10. Understand voltage

Outcome 4 Analyse systems and understand system operations

The candidates are able to:

1. Analyse network representation
    a. network equations method solution (iterative) (Gauss Seidel method) including
        i. per unit concepts
        ii. fault and unbalanced calculations
        iii. symmetrical components

2. Understand the concepts and calculations involved in steady state and transient stability
3. Understand step-by-step and equal area criterion
4. Understands methods used for increasing stability limits
5. Understands over voltage and surges on systems
    a. causes
    b. generation
    c. protection
6. Understand modern system control concepts
    a. digital systems
    b. data transmission links
    c. energy systems and management
    d. role of control engineers
7. Understand system frequency and voltage control from a control centre
8. Understand scheduling and dispatch generation for minimum operating
    a. cost
    b. reliability
    c. spinning reserve
9. Understand forms of system protection
10. Understand system safety requirements

SUBJECT DE204 – HIGH VOLTAGE ENGINEERING SYSTEM

(This syllabus is valid for examinations from March 2011)

SUMMARY

To provide candidates with an essential understanding of the principles and analysis of high voltage electrical systems including changes in practices and procedures and knowledge of prudent engineering practices in high voltage.

AIM

To develop the candidate's

iv. knowledge on high voltage electrical systems in relation to circuits, transformers, switchgear and control gear assemblies.
v. skills in the design and analysis of high voltage electrical systems.
vi. knowledge of prudent practices in the selection, operation and maintenance of high voltage electrical systems and use of measuring and testing techniques.

PREREQUISITE

Electrical and Electronic Engineering

LEARNING OUTCOMES

A candidate should be able to

(i) perform basic calculations on high voltage electrical systems, transformers, switchgears and control gear assemblies.

(ii) select equipments in the design of high voltage electrical systems.

(iii) analyse the performance of high voltage electrical systems, transformers, switchgears and control gear assemblies.

(iv) apply the use of measuring and testing instruments in high voltage electrical systems.

(v) design earthing and protection schemes.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

4. Develop a strategy for using application of mathematical skills over an extended period of time.
5. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:

    i. deductive and inferential reasoning
    ii. mathematical manipulation

6. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Perform basic calculations on high voltage electrical systems, transformers, switchgears and control gear assemblies.

The candidates are able to:

1. Understand high voltage electrical system:
    a. Transmission and distribution system
    b. Overhead and underground
    c. Long and short lines
    d. Ac and dc systems
2. Appraise the characteristics of high voltage electrical system, transformers, switchgear and control gear assemblies.
3. Recognise steady-state and transient responses.

Outcome 2 Select equipments in the design of high voltage electrical systems

The candidates are able to:

1. Select equipments such as

    a. equipments associated in high voltage system
    b. transformers
    c. switchgears
    d. control gear assemblies

Outcome 3 Analyse the performance of high voltage electrical systems, transformers, switchgears and control gear assemblies.

The candidates are able to:

1. analyse the voltage and frequency response in and steady-state and transient conditions.
2. analyse performance of protection systems

Outcome 4 Apply the use of measuring and testing instruments in high voltage electrical systems.

The candidates are able to:

1. Select the appropriate measuring instruments for high voltage applications.
2. Apply appropriate testing methods.

Outcome 5 Design earthing and protection schemes.

The candidates are able to:

1. Select the appropriate

a. earthing and protection system.
b. earthing and protection equipment.

2. Apply the above selection in the relevant scheme.

Reading List

High Voltage Engineering and Testing, Edited by Hugh M. Ryan, Publisher: The Institution of Electrical Engineers.
Advances in High Voltage Engineering, Edited by A. Haddad and D. Warne, Publisher: The Institution of Engineering and Technology.

SUBJECT DE205 –COMMUNICATION SYSTEMS

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content provides a comprehensive study on communication systems and engineering solutions including expectation and probable limitations of evolving communication technologies.

AIM

To enable the candidate to analyse, compare, utilise communication systems and apply knowledge in modern digital communications principles in complex signal processing.
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PREREQUISITE

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LEARNING OUTCOMES

A candidate should be able to:

i. Analyse problems of switching and transmission

ii. Compare quantitatively methods of source coding

iii. Utilise the design principles of optical communication

iv. Outline key constraints in mobile communications, together with principles of the GSM system.

v. Utilise the design principles of satellite communication

vi. Discuss modern digital communication systems

vii. Describe signals in the time, frequency and statistical domains, translate freely between these domains and evaluate the effect of transmission through a linear system.

viii. Outline the principles of digital transmission, line coding and modulation

ix. Explain elementary information theory and describe the purpose and principles of source coding and error control coding.

x. Describe noise and link budgets.

LEARNING HOURS

It is recommended that 360 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

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ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Analyse problems of switching and transmission.

The candidates are able to:

1. Analyse and investigate time and space switch problems.
2. Understand the principles of operation of digital telephone exchanges.
3. Analyse routing systems
   a. permanent circuits
   b. virtual circuits
4. Design alternative routing systems
5. Utilise traffic theory including Erlang's model
6. Understand the causes of system congestion
7. Analyse and rectify distortion and interference
   a. SQNR
   b. delay distortion
   c. aliasing
   d. inter-symbol interference
8. Compute bandwith and implement filtering techniques.

Outcome 2 Compare quantitatively methods of coding.

The candidates are able to:

1. Process sound, picture and multi-media data.
2. Instigate bandwidth reduction techniques.
3. Determine spectral and power efficiency.
   a. PSK
   b. FSK
   c. QPSK
   d. spectra
4. Determine binary error rates.
5. Operate demodulation techniques.

Outcome 3 Utilise optical communication design principles.

The candidates are able to:

1. Evaluate propagation in optical fibres.
   a. dispersion
   b. attenuation
2. Determine optimum wavelengths in optical fibres
3. Analyse the benefits and limitations of transmitters, LED's and lasers

4. Check the function of
   a. detectors
   b. PINS
   c. avalanche diodes
5. Determine noise, impulse and frequency responses
6. Determine bandwidth in optical communication systems
7. Implement WDM-modulation for multi-channel use.

Outcome 4 Outline key constraints in mobile communications.

The candidates are able to:

1. Recognise the implications of service requirements on system design
2. Determine present and future targets
3. Determine cell and cluster sizes
4. Express the multipath problem
5. Analyse modulation, speech and channel coding for
    a. GSM systems
    b. 3G systems
    c. UMTS systems
6. Manipulate data and appreciate network layer principles of
    a. GSM systems
    b. UMTS systems

Outcome 5 Utilise satellite communication design principles.

The candidates are able to:

1. Analyse satellite orbits, look angles and coverage.
2. Analyse transponder and earth station design.
3. Analyse propagation and link budgets.
4. Assess digital transmission, modulation and multiple access.
5. Recognise mobile radio applications of satellite systems.
6. Recognise broadband applications of satellite systems.

Outcome 6 Discuss modern digital communication systems.

The candidates are able to:

1. Describe the historical development of telecommunications services.

2. Describe the purpose of the following digital communications processes.

    a. sampling and anti-aliasing filtering
    b. quantization/reconstruction filtering
    c. pulse code modulation/demodulation
    d. source coding/decoding
    e. encryption/deciphering
    f. error control coding/decoding
    g. multiplexing/demultiplexing
    h. line coding/decoding
    i. pulse shaping/matched filtering
    j. bandpass modulation/demodulation
    k. multiple accessing
    l. equalization

3. Compare and contrast the advantages and disadvantages of line, radio and satellite transmission.
4. Describe and compare the transmission characteristics of twisted pair, coaxial cable and optical fibre transmission lines.
5. Describe and compare the dominant propagation mechanisms, noise processes and nominal ranges of different bands of the radio spectrum.
6. Suggest and comment on the advantages of digital communications compared with analogue communications.
7. Describe a range of telecommunication network applications.
8. Explain the fundamental network problem.
9. Distinguish between broadcast and switched networks.
10. Distinguish between LANs, MANs and WANs.
11. Describe a range of network structures (including star, tree, mesh, bus, ring) and represent them, where appropriate, using a connection matrix

12. Explain the following network switching philosophies
    a. circuit switching
    b. message switching
    c. packet switching
13. Explain the principles and advantages of a layered network architecture.
14. Describe the ISO-OSI 7-layer model of a communications system.
15. Describe the use of repeaters, bridges, routers and gateways to extend and interconnect networks.
16. Describe the structure of a national PSTN.
17. Explain what is meant by the transmission system, the switching system and the signalling system of a network.
18. Explain what is meant by the terms core network, access network, bearer network and service (or functional) networks.

Outcome 7 Describe signals in the time, frequency and statistical domains, translate freely between these domains and evaluate the effect of transmission through a linear system.

The candidates are able to:

1. Recognise and distinguish between periodic and non-periodic signals.
2. Recognise and distinguish between deterministic and random signals.
3. Recognise and distinguish between transient and non-transient signals.
4. Use analytical formulas to represent common periodic and transient signals in time and frequency domains.
5. Use probability distributions and statistics to describe random signals.
6. Translate simple signals between time and frequency domains using the Fourier series and Fourier transform.
7. Translate signals between time and frequency domains using tables of Fourier series, Fourier transforms and Fourier transform theorems.
8. Calculate the power spectra and autocorrelation functions of signals.
9. Relate power spectra and autocorrelation functions using the Wiener-Kintchine theorem.
10. Explain what is meant by cross-correlation function and correlation coefficient and calculate these for simple signals and random variables.
11. Describe the effect of a linear system using frequency response and/or impulse response, especially in the context of pulse transmission.
12. Relate the frequency response and impulse response of a linear system.
13. Describe the origin, effects and mitigating techniques for the following types of distortion
    a. loss
    b. amplitude distortion
    a. phase and group delay

Outcome 8 Outline the principles of digital transmission, line coding and modulation

The candidates are able to:

1. State, and apply, Nyquist's sampling theorem
2. Break the process of analog-to-digital conversion into sampling, quantization and pulse code modulation
3. Explain the process and significance of quantization
4. Explain what is meant by quantization noise
5. Calculate signal to quantization-noise ratios (sn_qr) for signals with uniform pdf
6. Describe pulse code modulation (PCM)
7. Explain the advantages of PCM
8. Calculate the signal-to-noise ratio (SNR) of a demodulated PCM signal
9. Explain the process and advantages of non-linear quantization and companding
10. Quantify the benefits of A-law companding
11. Describe centre point detection (CPD) as applied in simple baseband receivers
12. Derive and calculate the bit error ratio (BER) for a baseband CPD system in the presence of Gaussian noise
13. Explain what is meant digital signal regeneration and describe how it is achieved

14. Calculate the effect of error accumulation over multi-hop links using linear amplifiers or regenerative repeaters between hops
15. Describe the purpose and requirements of a line code
16. Describe the general properties of unipolar, polar, dipolar, and bipolar (AMI) line codes
17. Distinguish between return-to-zero and non-return-to-zero line codes
18. Describe HDB3, CMI and *n*b*m*t line codes
19. Explain the purpose of band-pass modulation
20. Describe the basic binary forms of digital modulation
    a. Amplitude shift keying (ASK)
    b. Frequency shift keying (FSK)
    c. Phase shift keying (PSK)
21. Sketch example waveforms, spectra and constellation diagrams for each of the binary modulation schemes
22. Show how each ASK, FSK and PSK signals could be generated in principle

Outcome 9 Explain elementary information theory and describe the purpose and principles of source coding and error control coding

The candidates are able to:

1. Summarise elementary information theory
    a. Explain and define the basic measures of information (bits, nats and hartleys)
    b. Explain and define entropy, redundancy and transmission (or code) efficiency
    c. Apply measures of information, entropy, redundancy and transmission efficiency to simple numerical problems
2. Explain the purpose and principles of source coding
    a. Implement a huffman code
    b. Describe source coding for speech, music (hi-fi), facsimile, pictures (jpeg) and video (mpeg)
    c. Define channel capacity (shannon-hartley law)
    d. Comment on the limiting factors of channel capacity (error rate due to noise and bit rate due to bandwidth) and the possible trade-off between these factors
3. Explain the purpose and principles of error control coding
    a. Define hamming distance and codeword weight
    b. Explain the principles of (n,k) block codes and the use of parity check digits
    c. Define the error detection and correction capability of a code
    d. Implement nearest neighbour and syndrome decoding of a block code
    e. Explain what is meant by a cyclic code and, in particular, the special case of a hamming code
    f. Explain the meaning and significance of interleaving

Outcome 10 Describe noise and link budgets

The candidates are able to:

1. Explain what is meant by additive noise, white noise and Gaussian noise
2. Explain why thermal noise can normally be assumed to be additive, white and Gaussian
3. Explain origin and characteristics of shot noise
4. Distinguish between internal and external receiver noise
5. Define noise temperature and noise figure and convert freely between the two
6. Calculate the overall noise temperature and noise figure of a system comprising multiple subsystems connected in cascade
7. Explain what is meant by antenna noise temperature
8. Sketch the typical noise temperature of a narrow beam antenna as a function of frequency for low and high elevation angles
9. Explain the origin of a dominant antenna noise at different frequencies
10. Explain and define antenna directivity, gain and effective area
11. Explain and define spreading loss, free-space path loss, plane Earth path loss and interference patterns due to ground reflection
12. Construct simple microwave or millimetre-wave link budgets for point-to-point terrestrial links

13. Describe what is meant by multipath fading and diversity reception in the context of a radio link
14. Explain the principles of optical fibre transmission including fibre construction, propagation modes and their characteristics
15. Give an elementary account of optical sources, detectors and amplifiers
16. Construct simple optical fibre link budgets

SUBJECT DE206 – CONTROL SYSTEMS ENGINEERING

(This syllabus is valid for examinations from March 2011)

SUMMARY

The content outlines the methods used for the design and evaluation of control systems.

AIM

To equip the candidate with the knowledge and skills required to design and evaluate control systems relating to mechanical, manufacturing, chemical and electrical engineering applications.

PREREQUISITE

Be familiar with complex variable theory, solution of 1st and 2nd order differential equations using time domain and Laplace techniques and the basics of applied mechanics.

LEARNING OUTCOMES

A candidate should be able to:

(i) Apply mathematical modelling to dynamic systems and analyse responses.

(ii) Evaluate instrumentation for measurement.

(iii) Assess the feedback and control systems.

(iv) Outline digital control systems.

(v) Use computer-based control system eg. programmable logic controller

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:

    i. deductive and inferential reasoning
    ii. algebraic manipulation
3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Apply mathematical modelling to dynamic systems and analyse responses.

The candidates are able to:

1. Apply mathematical modelling to lumped-parameter components, devices and systems with examples from some of the following areas

a. electrical
b. hydraulic
c. mechanical
d. pneumatic
e. thermal

2. Understand linearisation of dynamic equations about an equilibrium operating state
3. Use methods of system representation
   a. block diagrams and block diagram reduction
   b. transfer functions
   c. signal flow graphs
4. Understand systems with dead time
   a. distance/velocity lag
5. Understand the transient and steady-state response of first-order and second-order systems to the function inputs
   a. impulse
   b. step
   c. ramp
   d. sinusoidal
6. Analyse transfer function and state variable formulations of dynamic system equations including the effects of initial conditions
7. Understand response characterisation
   a. time constant
   b. undamped and damped natural frequencies
   c. damping ratio
   d. settling time
   e. rise time
   f. resonant frequency
   g. maximum of the modulus of the frequency response
   h. bandwidth
8. extend the above to higher order systems such as systems with a dominant time constant

Outcome 2 Evaluate instrumentation for measurement.

The candidates are able to:

1. Assess the performance characteristics of instruments
   a. static
      i. sensitivity
      ii. repeatability
      iii. resolution
   b. dynamic
      i. bandwidth
      ii. settling time
      iii. dead time

2. Assess transducers commonly used for the measurement of controlled variables, with examples from some of the following areas
   a. displacement
   b. velocity
   c. acceleration
   d. force
   e. torque
   f. power
   g. pressure
   h. temperature flow rate
   i. light
   j. sound
   k. time

3. Recognise and select types of instruments
    a. passive
    b. active analogue
    c. digital

4. Analyse signal conditioning and conversion
    a. bridge circuits
    b. operational amplifiers
    c. impedance converters
    d. digital filters
    e. microprocessors in relation to instrumentation

Outcome 3 Assess the feedback and control systems.

The candidates are able to:

1. Compare control systems without and with feedback.
2. Understand and manipulate open and closed-loop transfer functions.
3. Assess types of close-loop control systems and relationship with steady state errors.
4. Understand characteristic equation of closed-loop control system and the Routh-Hurwitz stability criterion.
5. Use design criteria
    a. stability margins
    b. steady-state errors
    c. performance indices in the time domain
    d. disturbance rejection
    e. concept of design sensitivity
6. Implement control algorithms by finite difference techniques (discrete mathematics).
7. Understand frequency diagrams
    a. Nyquist
    b. Bode
    c. Nichols
    d. stability criteria
    e. relative stability
    f. peak magnitude of frequency response
    g. gain and phase margins
8. Understand the root locus diagram
    a. stability criterion
    b. constraints on pole locations to satisfy damping ratio and speed response requirements
9. Apply closed-loop system response to disturbances with differing entry points.
10. Assess state variable formulation of the system equation; canonical transformation and canonical state variables.
11. Assess the implication of controllability and observability.
12. Understand the application of compensation techniques using frequency response and root loci design methods.
    a. lead/lag networks
    b. proportional - integral-derivative (PID) control
13. Understand pole placement by state vector feedback.
14. Understand digital compensation.

Outcome 4 Outline digital control systems.

The candidates are able to:

1. Describe the main features of computer based control systems.
2. Describe sampler/zero-order-hold systems.
3. Understand the Z-transform with sampling interval T.

4. Assess the relationship between Laplace variables S and Z and Z-transform inversion and final value theorem
5. Understand the Nyquist/Shannon Sampling-rate theorem and aliasing.
6. Understand poles and zeros in the Z-plane.
7. Establish criterion for system stability.

Outcome 5 Use computer-based control system

The candidates are able to:

1. Use digital applications in data acquisition and logging.
2. Apply programmable logic controllers (PLCs) in control systems.
3. Integrate knowledge into Distributed Control System (DCS).

SUBJECT DE207 – ELECTRICAL ENERGY UTILISATION

(This syllabus is valid for examinations from March 2011)

SUMMARY

To provide the candidate with an introduction to current electrical power engineering practice in power quality management and industrial power system.

AIM

This subject deals with current electrical power engineering practice covering areas on power quality issues, industrial power system planning, design and maintenance, and laws and regulation governing electrical engineering practice.

PREREQUISITE

Electrical and Electronic Engineering

LEARNING OUTCOMES

A candidate should be able to:

(vi) Recall the concept of power generation, transmission and distribution.
(vii) Calculate the value of capacitance for power factor correction in distribution power system.
(viii) Recognise the importance of electrical safety through earthing and other protective devices.
(ix) Demonstrate the knowledge of design criteria and procedure of electrical distribution and system installation.
(x) Analyse the major power quality disturbance, their effects, the possible causes and the mitigation techniques for the specific disturbances.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of mathematical skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:

    i. deductive and inferential reasoning
    ii. algebraic manipulation

3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Recall the concept of power generation, transmission and distribution.

The candidates are able to:

i. Describe the various methods of power generation.
ii. Describe the difference between transmission and distribution systems.

Outcome 2 Calculate the value of capacitance for power factor correction in distribution power system.

The candidates are able to:

i. Explain types of loads in distribution systems.
ii. Determine the power factor and its effects.
iii. Calculate the value of capacitance for power factor correction.

Outcome 3 Recognise the importance of electrical safety through earthing and other protective devices.

The candidates are able to:

i. Understand the importance of earthing and also the system earthing arrangement according to relevant MS (312-3) and IEC regulations.
ii. Understand the concept of protection against Electric Shock.
iii. Calculate the Earth loop impedance and understand its relation with the overcurrent protective device.

Outcome 4 Demonstrate the knowledge of design criteria and procedure of electrical distribution and system installation

The candidates are able to:

i. Apply technical knowledge in the design of bus bar arrangement, installation of Current Transformers, Voltage Transformer and protection devices.
ii. Comprehend legal issues relevant to Malaysian laws and regulations governing electrical installations, energy efficiency and renewable energy.

Outcome 5 Analyse the major power quality disturbance, their effects, the possible causes and the mitigation techniques for the specific disturbances

The candidates are able to:

i. Recognise the effect of power quality in distributions.
ii. Explain different types of power quality disturbances.
iii. Identify mitigation techniques to overcome the power quality disturbances.

Reading List

1. P. Cook, IEE Wiring Regulations: BS 7671:2001: Requirements for Electrical Installations, IEE Publication, 2002
2. B. Scaddan, IEE Wiring Regulations and Illustrated: A Practical Guide to BS 7671:2001, Butterworth-Heinemann, 2001.
3. J. Whitfield, The Electrician's Guide to the 16th Edition of the IEE Wiring Regulations BS 7671:2001, EPA Press, 2002.
4. Malaysian Electricity Supply Act 1990 – Act 447
5. The Malaysian Electricity Distribution Code (MEDC)
6. Fundamentals of Power Quality, Surya Ssantoso, Publisher : Amazon.com, 2006-9.
7. Electrical Power System Quality, Surya Santoso, H. Wayne Beaty, Roger C. Dugan and Mark F. McGranaghan, Publisher : McGraw Hill.
8. Power Quality in Electrical Systems, Alexander Kusco, Marc Thompson, Publisher : McGraw Hill, 2007.

SUBJECT DM201 – DYNAMICS OF MECHANICAL SYSTEMS

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about analysing engineering problems where dynamic behaviour is major consideration.

AIM

To develop the candidate's knowledge of the dynamic of rigid bodies, dynamics of machines and vibration of mechanical systems

LEARNING OUTCOMES

The candidate will able to:

(i) Solve problems involving three dimensional motion of solid bodies
(ii) Analyse common engineering machines and mechanism
(iii) Analyse vibration involved in mechanical systems

PREREQUISITES

Advisable for candidates who have completed CME101.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving
   a. deductive and inferential reasoning
   b. algebraic manipulation
3. Evaluate candidate's overall strategy and present the outcomes from candidate's work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Solve problems involving three dimensional motion of solid bodies

The candidates are able to:

1. Solve problems involving the motion of rigid bodies in three dimensions
   a. linear momentum
   b. moment of momentum (angular momentum)
   c. kinetic energy
2. Use the momentum equation of motion
   a. rotating frames of reference
   b. Euler's equations
   c. work/energy equations
3. Solve problems involving gyroscopic motion with steady precession
4. Analyse the effects of impulsive forces and moment of force

Outcome 2 Analyse common engineering machines and mechanisms

The candidates are able to:

1. Solve problems involving Kinetics of planar mechanisms with
   a. revolute (pin) joints
   b. prismatic (sliding) points
2. Solve problems involving forces and torques in planar mechanisms including those due to the inertia and moments of force associated with acceleration of the links
3. Analyse the balancing of rigid rotors
   a. the out-of-balance forces in single and multi-cylinder reciprocating engines, pumps and compressors
   b. the moments of force of the above

Outcome 3 Analyse vibration involved in mechanical systems

The candidates are able to:

1. Analyse free vibration of systems with two degrees of freedom
   a. undamped natural frequencies
   b. normal modes of vibration of undamped systems (eigenvalues and eigenvectors)
   c. the orthogonality principle
   d. coupling and beat phenomena
2. Analyse undamped and damped force vibration of systems with one degree and two degrees of freedom
   a. with forcing by harmonic displacement
   b. rotating out-of-balance
   c. force or moment of force applied to a body in the system
3. Investigate frequency response characteristics
   a. reasonant frequencies
   b. magnification factor and peak magnification
   c. modulus and phase diagrams
4. Determine the forces transmitted to supports
5. Examine the dynamic vibration absorber and the untuned viscous damper
6. Extend vibration analysis to undamped multi degress of freedom systems
   a. influence coefficients
   b. Holzer's method

7 Analyse free vibration of undamped continious systems
   a. longitudinal vibrations of bars
   b. torsional vibration of circular shafts
   c. flexural vibration of beams
   d. analytical solutions for simple systems
   e. Rayleigh's method for multi-body and continuous linear systems

SUBJECT DM202 – APPLIED THERMODYNAMICS

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about thermodynamic when applied to industrial power and refrigeration systems.

AIM

To provide the candidate with the knowledge required to understand the performance and behaviour of thermodynamic power and refrigeration systems and the component parts of these systems.

PREREQUISITES

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LEARNING OUTCOMES

The candidate will be able to:

i) Understand and apply the working relationships involved in the behaviour and performance of power and refrigeration cycles
ii) Solve realistic problems involving the steady flow of compressible fluids
iii) Analyse and solve problems associated with rotodynamic compressors and turbines and gas turbine cycles
iv) Analyse and solve problems associated with the reciprocating compressors and expandes and internal combustion engines
v) Understand the fundamental principles of mixtures of gases and vapours and of combustion processes.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy of using application of number skill over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   i. Deductive and inferential reasoning
   ii. Algebraic manipulation
3. Evaluate candidate's overall strategy and present the outcomes from candidate's work, including use of charts, diagrams and graphs to illustrate complex data.
4. Develop a strategy for using skills in problem solving over an extended period of time.
5. Monitor progress and adapt a strategy, as necessary, to achieve the quality of outcomes required when tackling one complex problem with at least three options.
6. Evaluate an overall strategy and present the outcomes from personal work using a variety of methods.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Understand and apply the working relationships involved in the behaviour and performance of power and refrigeration cycles

The candidates are able to:

1. Analyse steam turbine power cycles including
   a. effects of superheating
   b. reheating and regenerative feed heating

c. use of back pressure and pass-out turbines

2. Analyse gas turbine power cycles including
   a. effects of intercooling
   b. reheating and heat exchange
   c. influence of
      i. component efficiencies
      ii. pressure ratio
      iii. cycle temperatures
3. Analyse vapour compression refrigeration cycles including
   a. effect of expansion by throttling
   b. effects of working fluid state at
      i. compressor inlet
      ii. condenser outlet
      iii. choice of refrigerant

4. Explain the elements of simple ammonia-water absorption cycle.
5. Apply the principles of the heat pump and evaluate its application possibilities.

Outcome 2 Solve realistic problems involving the steady flow of compressible fluids

The candidates are able to:

1. Determine one-dimensional steady flow of gases and vapours through nozzles and diffusers and evaluate the effects of
   a. critical pressure ratio
   b. friction
2. Analyse and solve problems involving adiabatic flow through long pipes
3. Identify stagnation properties at a point in a fluid stream in terms of
   a. pressure
   b. temperature
   c. enthalpy
4. Analyse and solve problems involving simple jet propulsion systems in terms of
   a. momentum thrust
   b. pressure thrust
   c. specific impulse

Outcome 3 Analyse and solve problems associated with rotodynamic compressors and turbines and gas turbine cycles

The candidates are able to:

1. Solve problems involving positive-displacement expanders and compres
   a. reversible reciprocating machines
   b. isothermal and isentropic efficiencies
   c. reciprocating air compressors
      i. volumetric efficiency
      ii. multi-stage working with intercooling
   d. the steam engine as an expander
   e. rotary positive displacement compressors
2. Solve problems involving turbines and turbo-compressors
   a. mean-diameter treatment of kinematics and momentum transfer
   b. radial and axial-flow machines
   c. impulse and 50% reaction blading in axial-flow turbines
   d. sources of internal losses
   e. overall,stage and polytropic efficiencies reheat factor

Outcome 4 Analyse and solve problems associated with reciprocating compressors and expanders and internal combustions engines

The candidates are able to:

1. Analyse reciprocating internal combustion engines
    a. air-standard cycles underlying reciprocating engine processes
        i. otto
        ii. diesel
        iii. stirling
        iv. others
2. Determine the cycle efficiency and mean effective pressure as criteria of performance of reciprocating internal combustion engine
3. Explain the practical working of reciprocating internal-combustion engines
    a. determine factors limiting the performance of
    b. spark ignition engines
    c. compression-ignition engines
4. Determine the effects of variable specific heat and dissociation on engine cycle efficiency
5. Determine the relationship between air-standard cycles and reciprocating internal-combustion engine processes

Outcome 5 Understand the fundamental principles of mixtures of gases and vapours and combustion processes

The candidates are able to:

1. Analyse mixtures of gases and vapours and the relationship between specific and molar properties
2. Determine the effects of mixtures of gases and vapours on the performance of
    a. cooling towers
    b. condensers
3. Analyse air-conditioning plant
4. Use psychometric processes in terms of
5. Analyse combustion processes in terms of
    a. stoichiometry
    b. internal energy of reaction
    c. enthalphy of reaction and formation
6. Apply First Law of thermodynamics to chemical reactions
7. Explain chemical dissociation and determine its effect in reaction involving perfects gases

SUBJECT DM203 – HEAT TRANSFER

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about heat and mass transfer in stationary and following systems

AIM

To provide the candidate with the knowledge required to understand and analyse heat transfer and mass transfer systems employed in industrial processes

PREREQUISITES

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LEARNING OUTCOMES

The candidate will be able to:

i) Predict rates of heat transfer and mass transfer by on a simple geometries
ii) Predict heat and mass transfer coefficients in flowing systems using correlations appropriate for both forced and free convection
iii) Analyse the performance of heat exchangers, wetted-wall columns, packed towers, plate columns, humidification and drying equipment, and evaporators

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILL AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Mnitor progresses and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:
   a. Deductive and inferential reasoning
   b. Algebraic manipulation
3. Evaluate candidate's strategy and present the outcomes from candidate's work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Predict heat and mass transfer coefficient in flowing systems using correlations appropriate for both forced and free convention

The candidates are able to:

1. Define mass transfer as transport process
2. Apply fick's law
3. Determine molecular diffusivity
4. Determine molecular diffusivity
5. Determine film and penetration theory of mass transfer
6. Understand diffusion
   a. eddy diffusivity
   b. boundary layer diffusivity

7. Analyse mass transfer in two phase fluid systems
    a. counter current flow
    b. co-current flow
8. Analyse co-efficient of mass transfer
    a. film
    b. overall
9. Determine mass transfer between fluids and solids
10. Understand the fundamental of continuous separation processes
    a. operating and equilibrium lines
    b. multistage and differential contact separation
    c. concepts of theoretical stage
    d. stage efficiency and transfer units
11. Analyse simultaneous heat and mass transfer
    a. relationship between heat, mass and momentum transfer
    b. jH and jD factors
    c. psychometry
12. Analyse humidification and dehumidification
    a. direct contact water and gas cooling
    b. air conditioning
    c. drying

Outcome 3 Analyse the performance of heat exchangers, wetted wall columns, packed towers, plate columns, humidification and drying equipment and evaporators

The candidates are able to:

1. Appraise heat exchangers
    a. type of construction
    b. mean temperature difference
    c. effectiveness and number of transfer units
2. Assess the economic factors of heat exchange systems
    a. design of main types
    b. costings
3. Appraise the application of mass transfer processes
    a. distillation
        i. design
        ii. transfer process
    b. absorption
        i. design
        ii. transfer process
    c. extraction
        i. design
        ii. transfer process

SUBJECT DM204 – MACHINE DESIGN

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject introduces machine component design, joints and connections, gear design, bearing & spring selection, brake and clutch design and selection of power transmission.

AIM

To provide machine design fundamentals which include concepts of machine element analysis - design, failure modes, failure prevention, response of machine elements to loads theories of failure, fatigue, stress concentration and material selection.

To provide knowledge and skill pertaining to design and selection of various machine elements including machine joints and fasteners, plain and rolling element bearings, power transmission shafts, belts and chains, springs, gears, clutches and brakes.

PREREQUISITES

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LEARNING OUTCOMES

A candidate should be able to:

1. apply the fundamentals of mechanical engineering to comply with machine element analysis.

2. design various machine elements.

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:

    i. deductive and inferential reasoning
    ii. algebraic manipulation
3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Apply fundamentals of mechanical engineering to comply with machine element analysis.

The candidates are able to:

1. demonstrate an understanding of the overall design process.
2. determine the types of failure and suggest failure prevention.
3. appreciate fluctuating loads and fatigue.
4. select the type of material to be used.
5. analyse the response of machine elements to loads.
6. appreciate the theories of failure and stress concentration.
7. appreciate safety factor and reliability.
8. appreciate Geometry determination of failures

Outcome 2 Design various machine elements

The candidates are able to design:

1. Power transmission shafts
2. Machine joints and fastening methods
3. Springs
4. Gears and systems of gears
5. Brakes and clutches
6. Belts, chains, and wire ropes
7. Plain and rolling element bearings

Recommended References:

1) Jack A. Collins(2003) Mechanical Design of Machine Elements and Machines, A Failure Prevention Perspective. New York: John Wiley & Sons

2) G.E.Dieter (2000) 3rd Ed. Engineering Design: A Materials and Processing Approach, McGraw-Hill.

3) R.L. Mott, (2004) 4th Ed. Machine Elements in Mechanical Design, Pearson Prentice Hall.

4) D.G.Ullman, D.Ullman (2002) 3rd Ed. Mechanical Design Process, McGraw-Hill.

SUBJECT DM205 – QUALITY AND RELIABILITY ENGINEERING

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about the design process that leads to reliable systems with built-in-quality. It enables measurement of effectiveness and repeatability.

AIM

To develop in the candidate an awareness of artefact quality, reliability, safety, and maintainability by measurement and planning.

PREREQUISITES

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LEARNING OUTCOMES

The candidate should be able to:

i) describe the importance of quality and reliability
ii) methods for measuring and improving quality and reliability
ii) develop quality and reliability programmes plans

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

-

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Describe the importance of quality and reliability

The candidates are able to:

1. Define
   a. quality control and assurance
   b. specifications of quality
   c. engineering reliability
2. Explain the principles of Total Quality Control (TQC)
   a. measurement techniques for
      i. quality control
      ii. improvement
   b. Quality Function Deployment
   c. Quality Circles and improvement groups
   d. economics of quality
   e. Zero Defects concepts and mistakes proofing
   f. product liability
3. Define reliability, maintainability and availability
4. Determine reliability specifications
5. Explain the effects on safety of engineering quality and reliability by

a. accident avoidance using
    i. design aspects
    ii. human factors
b. risk analysis
c. event tree analysis
d. fault tree analysis
e. redundancy
f. common mode and common cause failures
g. reliability block diagrams and risk matrices
h. quality, environmental, health and safety integration (QUENSH)

Outcome 2 Use methods for measuring and improving quality and reliability

The candidates are able to:

1. State the general principles of metrology
2. Measure and test
    a. length
    b. angle
    c. form
    d. surface finish
    e. roundness
    f. gauging
3. Use coordinate measuring machines
4. Undertake on line inspection and testing using
    a. non destructive techniques
    b. vision systems
    c. electrical, mechanical and radiological methods
5. Inspect and evaluate the quality of raw materials
    a. for purchasing purposes
    b. control charts
    c. test of significance and confidence limits
    d. sampling schemes
    e. Seven Quality Tools
    f. and determine control system choice

Outcome 3 Develop quality and reliability programme plans

The candidates are able to:

1. Assess designs for reliability and safety
    a. institute reliability and safety development programmes
    b. implement testing and evaluate failure modes by
        i. statistical analysis
        ii. physical characteristics
        iii. test design
2. Assess testing and evaluate failure modes by
    a. Weibull hazard and probability plotting
    b. Lognormal probability plotting
    c. Duane analysis
    d. accelerated testing
3. Investigate the economics of reliability process improvement and the consequences of catastrophic failure
4. Develop checklists for plant design and installation
5. Understand Failure Mode, Effect and Critical Analysis (FMECA) for
    a. design
    b. process
    c. system
6. Understand availability, maintainability and life cycles when referring to reliability and safety

7. Understand the application of designed experimentation
    a. sources of extend variability
    b. process optimisation
        i. improvement by monitoring
        ii. improvement by rectification
8. Apply the following to the above
    a. Exploratory Data Analysis
    b. design of experiments
    c. Analysis of Variance (ANOVA)
    d. Taguchi methods
9. Apply data, collection systems, information feedback and control
    a. fault detection and trend control
    b. automated testing systems
        i. design
        ii. application
    c. expert systems for fault diagnosis in process plant
    d. condition monitoring techniques

SUBJECT DM206 – MANUFACTURING TECHNOLOGY

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about the range of commonly used manufacturing processes and associated materials of manufacture.

AIM

To develop the candidate's awareness of manufacturing processes and the limitations and opportunities placed on manufacturing by workplace behaviour, design constraints, economic aspects, automation and modelling.

PREREQUISTES

-

LEARNING OUTCOMES

The candidates will be able to:
(i) Material behaviour and treatment that is relevant to manufacturing of parts and components
(ii) Casting, moulding, cutting, machining, forming, joining and powder based processes
(iii) Automation of manufacturing processes and control systems

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using communication skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality outcomes required in work involving:
   a) **One** group discussion about a complex subject
   b) **One** extended written communication about a complex subject
3. Evaluate candidate's overall strategy and present the outcomes from candidate's work, using at least **one** formal oral presentation, including the use of two images to illustrate complex points.

ASSESSMENT

A three-hour written examination.

CONTENT

Outcome 1 Material behaviour and treatment that is relevant to manufacturing of parts and components

The candidates are able to:

1. Apply heat treatment to material to produce the desired properties
2. Conduct surface treatment and coating processes
   a. surface hardening
   b. PVD
   c. CVD
3. Assess a materials plasticity
   a. Von Misses and Treasca yield criterion
   b. Coulomb friction factors models
   c. Levy-Mises flow rule
   d. empirical equations to describe stress-strain relations

e. plastic anisotropy parameters for sheet metal

Outcome 2 Casting, moulding, cutting, machining, forming, joining and powder based processes

The candidates are able to:

1. Describe metal casting processes
   a. sand
   b. die
   c. investment
2. Describe polymer forming processes
   a. injection moulding
   b. rotational
   c. resin transfer
   d. thermoforming
   e. compression moulding
   f. extrusion moulding
3. Describe metal forming processes
   a. open and closed die forging
   b. cold forging
   c. tube making processes
   d. sheet drawing and pressing
   e. extrusion of solid and thin walled sections
   f. apply energy, slab and upper bound methods to calculate forming forces
4. Powder based methods
   a. production of metal powders,compaction and sintering, including isostatic compaction,
   b. design consideration of powder parts
5. Evaluate alternative design configurations for moulds and die in casting and forming processes
6. Describe mechanical cutting processes
   a. chip formation
   b. cutting forces and power estimation

SUBJECT DK201 –INSTRUMENTATION AND CONTROL

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject covers mathematical modelling of engineering processes, linearization of non-linear partial differential equations, representation and response of control systems, characterization of response, performance characteristics and types of instrument.

AIM

To equip the candidate with the knowledge and skills required to design and evaluate control systems relating to mechanical, manufacturing, chemical and electrical engineering applications.

PREREQUISITE

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LEARNING OUTCOMES

A candidate should be able to:

(xi) Apply mathematical modelling to dynamic systems and analyse responses.

(xii) Evaluate instrumentation for measurement.

(xiii) Assess the feedback and control systems.

(xiv) Understand advanced Process Control

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

1. Develop a strategy for using application of number skills over an extended period of time.
2. Monitor progress and adapt candidate's strategy, as necessary, to achieve the quality of outcomes required in work involving:

    i. deductive and inferential reasoning
    ii. algebraic manipulation
3. Evaluate the candidate's overall strategy and present the outcomes from his/her work, including use of charts, diagrams and graphs to illustrate complex data.

ASSESSMENT

A three-hour written examination.

CONTENT

<u>Outcome 1</u> Apply mathematical modelling to dynamic systems and analyse responses.

The candidates are able to:

1. Apply mathematical modelling to lumped-parameter components, devices and systems with examples from some of the following areas
    a. electrical

b. hydraulic
c. mechanical
d. pneumatic
e. thermal

2. Understand linearisation of dynamic equations about an equilibrium operating state
3. Use methods of system representation
   a. block diagrams and block diagram reduction
   b. transfer functions
4. Understand systems with dead time
   a. distance/velocity lag
5. Understand the transient and steady-state response of first-order and second-order systems to the function inputs
   a. impulse
   b. step
   c. ramp
   d. sinusoidal
6. Analyse transfer function and state variable formulations of dynamic system equations including the effects of initial conditions
7. Understand response characterisation
   a. time constant
   b. undamped and damped natural frequencies
   c. damping ratio
   d. settling time
   e. rise time
   f. resonant frequency
8. extend the above to higher order systems

Outcome 2 Evaluate instrumentation for measurement.

The candidates are able to:

1. Assess the performance characteristics of instruments
   a. static
      i. sensitivity
      ii. repeatability
      iii. resolution
   b. dynamic
      i. bandwidth
      ii. settling time
      iii. dead time
2. Assess transducers commonly used for the measurement of controlled variables, with examples from some of the following areas
   a. pressure
   b. temperature
   c. flow rate
3. Recognise and select types of instruments

Outcome 3 Assess the feedback control systems.

The candidates are able to:

1. Compare control systems without and with feedback.
2. Understand and manipulate open and closed-loop transfer functions.
3. Assess types of close-loop control systems and relationship with steady state errors.
4. Understand characteristic equation of closed-loop control system and the Routh-Hurwitz stability criterion.
5. Use design criteria
   a. stability margins
   b. steady-state errors
   c. performance indices in the time domain

d. disturbance rejection
e. concept of design sensitivity

6. Understand frequency diagrams
   a. Nyquist
   b. Bode
   c. Nichols
   d. stability criteria
   e. gain and phase margins
7. Understand the root locus diagram
   a. stability criterion
   b. constraints on pole locations to satisfy damping ratio and speed response requirements
8. Tuning of Feedback controllers
   a. Quarter decay ratio response, Ziegler and Nichols tuning method, Cohen and Cohn tuning method

Outcome 4 Advanced Process Control.

The candidates are able to:

1. Understand various control methods such as ratio control, feed forward control, cascade control and model based control.

Recommended references

Johnson, C.D., Process Control Instrumentation Technology, (8th Edition), Pearson Education, New Jersey, 2006.

Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., Process Dynamics and Control, (2nd. Edition), John Wiley & Sons, Hoboken, NJ, 2004.

Marlin, T.E., Process Control: Designing Processes and Control Systems for Dynamic Performance, McGraw Hill, Singapore, 2000.

SUBJECT DK202 – HEAT, MASS AND MOMENTUM TRANSFER

(This syllabus is valid for examinations from March 2011)

SUMMARY

The subject covers the physical mechanisms associated with transport by conduction, convection and radiation as well as the principles of fluid mechanics. Additionally, it covers fluid systems analysis and performance studies.

AIM

To provide knowledge and to develop understanding and analytic skills of Heat, Mass and Momentum Transfer on stationary and flow systems as well as some industrial applications of these transports.

PREREQUISITIES

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LEARNING OUTCOMES

A candidate should be able to:

(i) Understand and apply the fundamentals and principles of fluid flow
(ii) Analyse the principles and application of turbo machinery
(iii) Understand and apply the fundamentals and principles of heat conduction and mass diffusion for steady state and unsteady state systems
(iv) Understand and apply the fundamentals and principles of convective heat and mass transfer
(v) Understand and apply the fundamentals and principles of heat transfer by radiation
(vi) Analyse the performance of mass and heat transfer equipment
(vii) Understand and apply the fundamentals and principles boiling and condensation

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

ASSESSMENT

A three hour written examination.

CONTENT

Outcome 1 Understand and apply the fundamentals and principles of fluid flow

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The candidates are able to:

1. define compressible and incompressible fluids

2. describe the kinematics of fluid motion in terms of
   a. streamlines
   b. stream tubes
   c. particle paths
   d. streak lines

3. define
   a. irrotational and rotational flows
   b. circulation
   c. vorticity

4. develop stress-strain relations for
   a. Newtonian fluids
   b. Non-Newtonian Fluids

5. determine and apply geometric, kinematics and dynamic similarity conditions in fluid systems

6. solve problems using
   a. Buckingham π theorem
   b. dimensional analysis

7. derive the principal dimensionless parameters of fluid flows
   a. Reynolds number
   b. Froude number
   d. pressure number
   e. roughness ration

   and perform calculations involving these dimensionless numbers

8. Determine and apply laminar flow in pipes and between flat plates

9. Calculate the velocity distribution and volumetric flowrate in laminar flow

10. Calculate the drag on a flat plate in laminar and turbulent flows

11. Understand the basic concept of boundary layer theory

12. Analyse the relationship between friction factor, Reynolds number and relative roughness in steady flow

13. Apply Bernoulli equations to incompressible inviscid fluid flows with and without frictional loss

14. Analyse the behaviour of single particles in a fluid in terms of
   a. Stokes Law for spherical particles
   b. drag coefficient
   c. Reynolds number effects
   d. terminal velocity

15 analyse flow in packed beds using
   a. Darcy's law
   b. Carmen-Kozeny equation

Outcome 2 Analyse the principles and application of turbo machinery

The candidates are able to:

1. Discuss different types of "turbo machinery" for fluid flow (eg; pumps, fans, etc)

2. Apply dynamic similarity to turbo-machines in terms of
   a. flow head and power coefficients
   b. specific speed
   c. characteristic performance curves
   d. net positive-suction head (NPSH)

3. Analyse turbo-machinery systems in terms of
   a. system load line
   b. pump and turbine operating conditions

Outcome 3 Understand and apply the fundamentals and principles of heat conduction and mass diffusion for steady state and unsteady state systems.

The candidates are able to:

1. Perform materials and energy balances
2. Apply heat transfer by conduction
   a. steady-state conduction through

      i. slabs
      ii. composite walls
      iii. cylinders
      iv. fin

   b. Unsteady-state conduction in homogeneous solids

3. Apply mass diffusion for steady state and unsteady state systems
   i. Apply fick's law
   ii. Determine molecular diffusitivity

Outcome 4 Understand and apply the fundamentals and principles of convective heat and mass transfer.

The candidates are able to:

i. Determine heat transfer by convection
   a. natural convection
   b. forced convection
      i. internal flow
      ii. external flow
      iii. around tube bundles
2. Determine mass transfer by convection
   a. in laminar flow
   b. in turbulent flow
   c. analogy between momentum, heat and mass transfer
   d. analyse coefficients of mass transfer
      i film
      a. overall (e.g. air cooled exchangers, jacketed vessels, external coils etc.)

Outcome 5 Understand and apply the fundamentals and principles of heat transfer by radiation

1. Determine heat transfer by radiation
   a Laws of radiation heat transfer, e.g. Planck's Law, Stefan-Boltzmann Law
   b Radiant heat transfer between black bodies and grey surfaces
   c Radiation from gases
   d The radiation heat transfer coefficient
   e Geometric factors
   f. Emissivity and absorptivity of solid surfaces

Outcome 6 Analyse the performance of mass and heat transfer equipment

1. Appraise the application of heat transfer processes
   a. heat exchangers
   b. mean temperature difference

c. effectiveness and number of transfer units

2. Appraise the application of mass transfer processes
   a. Packed column
   b. Wet wall

Outcome 7 Understand and apply the fundamentals and principles of humidification, boiling and condensation

   b. Humidification
      a. j factors
      b. Psychrometry
   c. Condensation on vertical and horizontal surfaces
      i. Filmwise
      ii. Dropwise
   b. Boiling
      i. nucleate
      ii. film
      iii. critical heat influx

Recommended references

- *Perry, R.H. and Green, D.W., Perry's Chemical Engineers' Handbook, (Platinum Edition), McGraw-Hill, New York, 1999.*
- *Incropera, F.P. and De Witt, D.P. Introduction of Heat and Mass Transfer, (5th Edition), John Wiley & Sons, Hoboken, NJ, 2002.*

SUBJECT DK203 – MATERIAL AND ENERGY BALANCE

(This syllabus is valid for examinations from March 2011)

SUMMARY

The subject is about carrying out a mass and energy balance for a steady state system, to enable calculations for the design and operations of chemical processes.

AIM

To provide fundamental principles of material and energy balance necessary for the purpose of designing chemical processes and operations.

PREREQUISITES

Refer to General Guidelines.

LEARNING OUTCOMES

A candidate should be able to:

(i) prepare flow sheet and determine the process variables involved including the units and dimensions

(ii) analyse the behavior at steady state flow system (single or multiphase) in terms of process variable such as temperature, pressure, flow rates and composition

(iii) perform steady-state mass and energy balance on an entire process or on subsets of that process

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCES

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ASSESSMENT

A three hour written examination

CONTENT

Outcome 1 Prepare flow sheet and determine the process variables involved including the units and dimensions

The candidates able to:

1. Explain concept of units and dimension
2. Develop process flow sheets
3. Determine degree of freedom
4. Extract relevant information from the flow sheet

Outcome 2 Analyse the behavior at steady state flow system (single or multiphase) in terms of process variable such as temperature, pressure, flow rates and composition.

The candidates are able to:

1. Apply principles of steady state conditions
2. Develop mass balance for unreactive system
3. Develop mass balance for reactive system
    a. stoichiometry
    b. extents of reaction
    c. conversion
    d. yield and selectivity
4. Prepare and analyse complex flow sheets
    a. multistage processes
    b. recycles
    c. bypasses and purges
5. Develop energy balance
    a. phase changes
    b. ideal and non-ideal mixtures
    c. enthalpies of reaction
    d. simple separation equilibria
    e. effects of temperature
    f. isothermal, adiabatic and non-adiabatic processes
    g. combustion system
6. Use thermodynamic tables

Outcome 3 Perform steady-state mass and energy balance on an entire process or on subsets of that process

The candidates are able to:

1. Establish choice of basis
2. Perform mass balance calculation
3. Perform energy balance calculation

SUBJECT DK204 – SEPARATION PROCESSES

(This syllabus is valid for examinations from March 2011)

SUMMARY

The subject is about the physical bases of separation processes involving gas absorption, distillation, liquid extraction, fluid-solid systems and other common methods.

AIM

To provide an understanding of the physical bases involved in selected separation processes.

PREREQUISITIES

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LEARNING OUTCOMES

A candidate should be able to:

(i) uderstand and analyse gas absorption/desorption (stripping).
(ii) understand and analyse distillation.
(iii) understand and analyse liquid-liquid extraction

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

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ASSESSMENT

A three hour written examination.

CONTENT

Outcome 1 Understand and analyse gas absorption/desorption (stripping).

The candidates are able to:

1. Interpret ideal and non-ideal gas-liquid equilibrium data
2. evaluate the mass transfer requirements of absorption and stripping columns using
   a. transfer unit method
   b. theoretical method
3. Assess and correlate/predict efficiency of plate and packed columns
4. Assess fluid mechanism related to the design of plate and packed columns
5. Assess methods used for economic optimization of design

Outcome 2 Understand and analyse distillation

The candidates are able to:

1. Analyse, predict and correlate vapour-liquid equilibrium data
   a. binary
   b. ternary

c. multi-component
2. Describe and analyse steady-state distillation including the fundamentals of stagewise continuous distillation processes applied to
   a. binary mixture
   b. multi-component mixture
3. Solve problems involving varying molal overflow
4. Describe and analyse flash distillation
5. Assess
   a. vacuum instillation
   b. steam distillation
6. Describe and analyse batch distillation
   a. with and with-out hold-up
   b. time to reach equilibrium
7. Assess and correlate/ predict efficiency of plate and packed columns
8. Assess and optimize the design of distillation equipment
9. Assess method used for economic optimization of design

Outcome 3 Understand and analyse liquid-liquid extraction

The candidates are able to:

1. Determine and represent phase equilibrium in immiscible/ partially miscible liquid-liquid system
2. Select solvents
3. Calculate the equilibrium stage requirement in batch and in continuous co-current and counter-current extractions
4. Apply the transfer unit method of column design
5. Assess counter- current extraction with reflux
6. Assess fluid mechanics in columns and mixer settlers
7. Assess and correlate/predict efficiency of plate and packed column rate data
8. Assess the design of liquid-liquid-extraction equipment
9. Analyse economic optimization methods of design

Outcome 4 Understand and analyse various fluid-solid separation processes

The candidates are able to:

1. Analyse leaching
   a. use of equilibrium data
   b. equilibrium stage calculations in co-current and counter-current leaching
   c. rate of leaching
   d. leaching equipment design
2. Analyse fluid solids and separation processes
   a. sedimentation and thickening
   b. flotation
   c. filtration equation
   d. filtration equipment types
3. Understand the general principles of precipitation and crystallization
   a. process fundamentals
   b. equipment selection

SUBJECT DK205 – CHEMICAL THERMODYNAMICS AND REACTOR DESIGN

(This syllabus is valid for examinations from May 2009)

SUMMARY

The subject is about the chemistry and chemical engineering concerned with the thermodynamics and kinetics of chemical reactions, the thermodynamics of phase behaviour, and the design of chemical reactors.

AIM

To provide basic concepts of chemical thermodynamics and design of reactors for industrial processes.

PREREQUISITIES

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LEARNING OUTCOMES

A candidate should be able to:

(i) appreciate and analyse chemical thermodynamics and phase uquilibria

(ii) appreciate and analyse the kinetics of chemical reactions

(iii) understand heterogeneous catalysed reactions

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

SKILLS AND COMPETENCIES

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ASSESSMENT

A three hour written examination.

CONTENT

Outcome 1 Appreciate and analyse chemical thermodynamics and phase uquilibria

The candidates are able to:

1. Appreciate the concept of reversible work and free energy
2. Calculate the temperature and pressure dependence of free energies
3. Determine free energy functions
4. Describe and calculate fugacity and activity
5. Appreciate the standard-state concept
6. Assess quantitatively free energy and equilibrium
7. Describe phase equilibria
8. Determine t and p dependence of free energies
9. Apply the gibbs-helmholtz equation
10. Determine solubilities of solid, liquids and gases
11. Apply raoult's and henry's laws
12. Determine activity coefficients
13. Use the gibbs-duhem equation and perform thermodynamic consistency tests

14. Ascertain chemical equilibrium and determine t and p dependence
15. Recognize and able to calculate, using table of data
    a. standard free energies
    b. enthalpies
    c. entropies
16. Assess equilibrium constants
17. Describe gas and liquid phase reaction with t and p dependence
18. Investigate reversible electrochemical cells and standard electrode potentials
19. Appraise concentration cells
20. Analyse experimental determination of thermodynamic data

Outcome 2 Appreciate and analyse the kinetics of chemical reactions.

The candidates are able to:

1. Use simple homogeneous rate equations
2. Assess overall rates
3. Analyse temperature dependence of reaction rates
4. Apply the arrhenius equation and understand the role of an activated complex
5. Determine
    a. equilibrium constants
    b. rate constants
    c. free energy of reaction
    d. free energy of activation
    e. activation energy and frequency factors
6. Analyse collision theory and frequency factors
7. Interpret experimental result, determine reaction order and calculate activation energies
8. Understand parallel and consecutive reactions
9. Apply the concept of rate limiting steps
10. Determine the effect of temperature on relative rates of competing processes
    a. reaction
    b. diffusion
11. Assess reaction which are
    a. chain
    b. isothermal
    c. adiabatic
12. Appreciate free radicals

Outcome 3 Understand heterogeneous catalysed reactions.

The candidates are able to:

1. Analyse physical adsorption and chemisorption
2. Determine the enthalpy of adsorption and dependence of surface coverage on
3. Temperature and pressure
4. Determine surface areas by langmuir and bet isotherms
5. Determine adsorption coefficients
6. Apply rate equations of simple reactions
    a. first and second order
    b. adsorption- desorption controlled
    c. surface reaction controlled
7. Assess the significance of the specific rate constants in reactions

SUBJECT DK206 – PLANT AND EQUIPMENT DESIGN

(This syllabus is valid for examinations from March 2011)

SUMMARY

The subject covers process design, engineering economics, mechanical design, equipment design and plant design. Additionally, it covers chemical process flowsheeting and preliminary chemical plant design.

AIM

To provide knowledge and to develop basic chemical engineering principles to the design of a process up to the standards which are currently applied in industry as well as to learn how to read and draw process flow diagrams.

PREREQUISITIES

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LEARNING OUTCOMES

A candidate should be able to:

(viii) Describe processes involve in chemical processing and synthesize process flow sheet for selected chemical process plant
(ix) Select equipment, perform process integration and carry out the equipment design and economic analysis on the proposed flow sheet
(x) Perform material selection and mechanical design of chemical unit operation
(xi) Analyze and evaluate preliminary design on selected chemical process plant with consideration of aspects related to safety, environmental, and sustainable development

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject.

ASSESSMENT

A three hour written examination.

CONTENT

Outcome 1 Describe processes involve in chemical processing and synthesize process flow sheet for selected chemical process plant

The candidates are able to:

a. Perform design synthesis
b. Carry out feasibility study and process selection
c. Develop chemical process flow sheet using suitable methods such as Douglas hierarchy approach etc.
d. Conduct material and energy balances
e. Analyse and evaluate the process flow sheet

Outcome 2 Select equipment, perform process integration and carry out the equipment design and economic analysis on the proposed flow sheet.

The candidates are able to:

a. Carry out selection of equipment depending on process

i. Reactor equipment
ii. Heat transfer equipment
iii. Separation equipment

b. Perform process integration
i recycle network
ii heat integration using pinch technology

c. Perform equipment design such as reactors, heat exchangers, condensers, evaporators, distillation column, absorption column, stripping tower etc.

d. Perform economic analysis
i cash flow
ii internal rate of return, payback period
iii cost components and capital investment

Outcome 3 Perform material selection and mechanical design of chemical unit operation.

The candidates are able to:

a. identify factors affecting material selection
i. corrosion
ii. properties of materials
iii. economics involved in selection of materials

b. mechanical design
i determine maximum allowable pressure
ii determine wall thickness
iii selection of equipment support

Outcome 4: Analyze and evaluate preliminary design on selected chemical process plant with consideration to safety, environmental, and sustainable development

a. Safety aspect

i. Inherent safety design
ii. Hierarchy of hazard control
iii. Hazard identification
iv. Comply with relevant regulations e.g. CIMAH, USECHH

b. Environmental aspect
i. Waste treatment
ii. Pollution control
iii. 3R principles – reduce, recycle, re-use
iv. Comply with relevant regulations e.g. Environment Quality Act etc.

c. Sustainable development aspect
i. clean development mechanism
ii. green engineering and cleaner technology

d. Optimization of process flow sheet using computer softwares

Recommended references

- *Biegler, L.T., Grossmann, E.I. and Westerberg, A.W., Systematic Methods of Chemical Process Design, Prentice Hall, Singapore, 1997.*
- *Perry, R.H. and Green, D.W., Perry's Chemical Engineers' Handbook, (Platinum Edition), McGraw-Hill, New York, 1999.*
- *Peter, M., Timmerhaus, K. and West, R., Plant Design and Economics for Chemical Engineers, (5th Edition), McGraw-Hill, New York, 2002.*
- *Sinnot, R.K., Coulson and Richardson's Chemical Engineering -Volume 6, (3rd Edition), Butterworth-Heinemann, Oxford, 2003.*
- *Ulrich, G.D. and Vasudevan, P.T., Chemical Engineering Process Design and Economics - A Practical Guide, (2nd Edition), John Wiley & Sons, Singapore, 2003.*

SUBJECT DK207 – HEALTH, SAFETY AND ENVIRONMENT

(This syllabus is valid for examinations from March 2011)

SUMMARY

This subject is about aspects of health, safety and environment in the process industries, identifying potential hazards and means to manage them, and the relevant laws and regulations.

AIM

To provide basic concepts of health, safety and environment in the workplace relevant to chemical industry.

PREREQUISITIES

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LEARNING OUTCOMES

A candidate should be able to:

(i) Identity chemical pollutants and be able to decide on the type of treatment plants for air water as well as solid waste
(ii) Identify the potential hazards including their consequences at the work place and be able to recommend ways to manage the hazards
(iii) Recognize the relevant laws and regulations on health, safety and environment (OHSAS and EQA)

LEARNING HOURS

It is recommended that 300 hours should be allocated for this subject

SKILLS AND COMPETENCIES

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ASSESSMENT

A three hour written examination

CONTENT

Outcome 1 Identity chemical pollutants and be able to decide on the type of treatment plants for air water as well as solid waste.

The candidates are able to:

1. Identity major pollutants in air and method of treatment
   a. SOx, NOx and COx
   b. desulphurisation
   c. pre and post combustion
   d. other combustion related pollutants
   e. method of treatment

2. Identify major pollutants in water and wastewater and methods of treatment
   a. COD, BOD VOC, toxic organic compounds
   b. precipitation and ion- exchange
   c. adsorption, steam stripping, solvent extraction and chemical oxidation
   d. biological growth and biological oxidation
   e. biological effluent treatment

Outcome 2 Identify the potential hazards including their consequences at the work place and be able to recommend ways to manage the hazards

The candidates are able to:

1. Identify toxic chemicals and the degree off toxicity including chemical and physical properties
2. Identify methods to manage the toxic materials
   a. Effect at the toxic materials to people and the environment
   b. Relationship between effect and dosage
3. Identify hazards in the chemical industry and their consequences
4. Determine methods to identify hazards
   a. HAZOP
   b. fault tree analysis
5. Determine methods to manage and present hazards
   a. risk analysis
   b. risk evaluation
   c. risk reduction and management

Outcome 3 Recognize the relevant laws and regulations on health, safety and environment (OHSAS and EQA)

The candidates are able to:

1. Explain the important elements related to relevant law and regulation for health, safety and environment.
   i. OHSAS
   ii. EQA and regulation