AM SYLLABUS (2015)

ENGINEERING DRAWING　　　　　　　　　AM 09

SYLLABUS

Engineering Drawing	**AM09** (Available in September)
Syllabus	Paper I (3 hrs) + Paper II (3 hrs) + CAD coursework

Aims

The aims of the syllabus are:

a) to explore further and confirm the direct relevance of engineering drawing to the varied design applications found in engineering and technology in general;
b) to further the ability to communicate engineering information by engineering drawings;
c) to develop further the skill of representing design concepts and solutions using both freehand and accurate drawings;
d) to develop an accurate level of draughtsmanship that respects established draughting codes, practices and conventions;
e) to develop a knowledge of two-dimensional (2D) computer-aided draughting (CAD).

Assessment Objectives

Candidates will be required to:

a) demonstrate their ability to read and evaluate engineering design drawings;
b) demonstrate their ability to apply the principles of plane and descriptive geometries to solve engineering problems;
c) model, orthographically and in three dimensions, problem situations utilising the most appropriate methods and techniques;
d) produce neat, clear and proportional drawings consistent with recognised codes and conventions;
e) produce computer-generated drawings using computer-aided design software.

It is anticipated that this syllabus will form a two-year course with a time allocation of around 360 hours. Candidates following this course are assumed to hold a pass grade of the SEC29 Graphical Communication syllabus.

Scheme of Assessment

Engineering Drawing shall have a continually assessed CAD component and a written examination as detailed below.

The final grade (grade A to grade E) shall be based on the combined marks obtained in the written examination and the CAD portfolio. To qualify for a pass in the subject, candidates **must** satisfy the examiners in both parts.

Marks distribution
Written examination: 85% of total marks
CAD portfolio: 15% of total marks

i)   The written examination

The examination will consist of two written papers, Paper I and Paper II, of three hours duration each. Paper I and Paper II carry equal weightings of marks. The candidates **must** satisfy the examiners in both papers.

Any examination question can test material from more than one topic.

Candidates are required to provide their own A2 size drawing board and draughting equipment. In particular the candidates should have a superbow compass capable of handling measurements of around 160mm. Such a compass should also be expandable, by the fitment of a matching extension.

Only non-programmable calculators are allowed. The use of draughting aids is permitted.

Questions in both papers will be set in SI units and in accordance with the revised editions of PP8888-1 and PP8888-2.

ii)   The CAD portfolio

Each candidate shall present a portfolio of three hard-copy, graded CAD practical exercises (tests), previously set by MATSEC to cover the syllabus. The first two exercises will be held during the first year of the course, with the third exercise left for the second year. Each test will last for two hours. The dates and times of the tests are fixed by the MATSEC Board. These exercises shall be marked by the class tutor during the two-year course, according to a marking scheme, guide-lines and instructions issued by MATSEC. The portfolio shall be submitted to the MATSEC Board by a fixed date prior to the written examination.

Private candidates

Private candidates will be required to make their own arrangements to be able to sit for the progressive CAD tests. They are advised to approach a post-secondary institution offering the subject and make a formal request to be able to sit for the CAD tests with the other regular students attending the institution. In this way private candidates will present the CAD competence folio just as well. The private candidates will however be allowed, if they so wish, to sit for all the three CAD tests in one scholastic year.

The Subject Content

The written examination

Paper I (max 100 marks)

Paper I is common to both Graphical Communication (AM15) and Engineering Drawing (AM09). It will contain six questions of which the candidates are required to answer any five. All questions will carry equal marks. All five questions are to be answered on A2 size sheets, which will be provided.

1.   The cone and the conic sections.

Conics regarded as sections of a right cone.
Conics regarded as plane loci of a moving point using the ratio of eccentricity.
The construction of a tangent and a normal at a point on the conics.
The construction of a tangent and a normal to the ellipse and parabola from a given point outside the curve.
Use of the focal sphere to find the ratio of eccentricity, the position of the directrix and the focal point/s of a conic.
Drawing the conics using the following methods:
   o   the parabola in a rectangle;
   o   the ellipse using the auxiliary circles;
   o   the ellipse in a rectangle;
   o   the ellipse using the intersecting arc method, $PF_1 + PF_2 = V_1V_2$;
   o   the hyperbola given the asymptotes and a point on it;
   o   the hyperbola using the intersecting arc method, $PF_1 - PF_2 = V_1V_2$.
The hyperbola and the auxiliary circle. Knowing the directrices, finding the asymptotes and vice versa.
The centre of curvature at a point on the ellipse, parabola and hyperbola, the point not being a vertex.

2.   Cycloidal curves

The construction of the cycloid, epicycloid, hypocycloid and their derived curves.
The tangent, normal and centre of curvature at a point on the cycloid and its trochoids.

3.   Spiral curves

The Archimedean spiral: the drawing of one or more convolutions extending between two given radii; the tangent and normal at a point on it.

4.   **Helices and screw threads**

The helix: right-hand and left-hand.
The true length of the helix.
The helix angle, excluding its application as being the true angle of the tangent drawn at any point on the helix.
Applications of the helix: the helical vane; round-, square- and rectangular-section springs; one- and two-start, internal or external, vee and square threads.

5.   **Involute Spur Gears**

The involute of a circle.
The analysis and drawing of gears in mesh. The number of teeth to be drawn in mesh shall be limited to five.
The construction of a gear tooth profile of an involute spur gear. Draw the tooth side using both the true involute method and approximate reproductive methods.
The rack and pinion.

6.   **Coplanar loci of points on moving mechanisms.**

Slider-crank mechanism.
Equal and unequal connected cranks.
Watt's straight-line motion.
Quick-return mechanism.
Geared link mechanisms.
The drawing of displacement diagrams related to the above.

7.   **Cams**

Types of motion: Dwell, Uniform Velocity (UV), Simple Harmonic Motion (SHM), Uniform Acceleration (UA), Uniform Retardation (UR), and Uniform Acceleration and Retardation (UAR).
Types of followers: knife-edged, flat-foot and roller-ended.
The line of action of the follower may be in-line or offset relative to the axis of the cam.
Types of cams: wedge, disc, cams with radial arm followers and end cams.
Problems will only be set to derive the cam profile from given cam and follower data.

8.   **Projections**

Isometric projection and the use of the isometric scale.
First and second auxiliary projection of shapes and solids.

9. Projection of Lines

Lines inclined to the horizontal plane (H.P.) and the vertical plane (V.P.); the determination of their true lengths, their true inclination to the H.P. and the V.P.
Skew lines; the shortest distance between two skew lines; the bearing and slope of the shortest distance.

10. Planes

Planes inclined to the horizontal plane (H.P.) and the vertical plane (V.P.); true angles between two planes: the dihedral angle.
The lines of intersection between two triangles or other plane laminae.

Oblique planes and their traces; the conversion of an oblique plane into a perpendicular inclined plane by means of auxiliary views; the true inclination to the horizontal and vertical planes determined using auxiliary projection or the technique of rabatment.

Lines, geometrical shapes and solids resting on, or cut by oblique planes.

11. Intersection of Solids

Intersections of geometrical solids, between:
   a) two prisms;
   b) two cylinders;
   c) prism and cylinder;
   d) cone and prism/cylinder;
   e) pyramid and prism/cylinder;
   f) sphere/hemisphere and prism/cylinder;
   g) sphere and cone.

All solids are right, with the cones and pyramids standing on their bases.
Prisms and cylinders may be inclined to one plane of reference.
All above categories may include cases of offset middle planes.

The construction of the curve of intersection that results on:
   a) palm-ended rods and eccentric cylinders;
   b) rods of hexagonal section joined to cones or spheres.

12. Solids in contact

Spheres in mutual contact with each other.
Spheres in contact with cones standing on their base.
The projection of the points of contact.

13. Developments

The development of surfaces of right and oblique truncated prisms, cylinders, cones and pyramids.

Development by triangulation of transition pieces; the end connections may have different cross-sections, not necessarily parallel to each other.

14. Graphical Statics

Coplanar concurrent and non-concurrent forces.
The use of Bow's notation, the polar diagram and the link polygon to determine graphically the resultant/equilibrant of a system of forces.

Shear Force and Bending Moment diagrams for:
a)   light cantilevers;
b)   light simply supported beams;
c)   light hinged beams - the beam is made of two parts, hinged together,
when these are subjected to vertical point loads and uniformly distributed loads (udl).

Framed structures; the use of space and force diagrams to framework problems to determine graphically the reactions and forces in members; the distinction between struts and ties. The applied external loading is limited to vertical point loads.

Paper II (max 100 marks)

Paper II will consist of four questions. The first is compulsory and carries 60% of the total marks. Candidates will choose two of the remaining three questions. These two questions share equally the remaining 40% of the marks.

Candidates will answer the questions on A2 drawing sheets, which will be provided.

It is of paramount importance that the candidates be able to interpret and produce engineering drawings to relevant British and equivalent ISO standards. The candidates should be familiar with the application of these standards, regarding them as reference documents.

Knowledge of the topics covered in Paper I is assumed. Paper II will cover the following topics:

1. Layout and Presentation

Sheet layout of drawings to modern drawing office practice, including blocks for items such as title, date, drawing and job number, scales, materials and parts list, item (balloon)

reference, material specification, treatment and finish and general tolerance. The sizes and types of drawing paper in use.
The layout and presentation of drawings should be in accordance with BS 8888 or the equivalent international ISO standard.

2.   Orthographic Projection

First and Third Angle projections with the use of hidden detail, sectional views and auxiliary views. Conventional practice as applied to sectional drawings. Symbols and abbreviations.

The production of assembly drawings from detail drawings of separate parts or vice versa. Although not limited to the following, the exercises may feature components of engines, compressors, pumps, non-return valves, safety valves and stop valves, couplings, simple clutches, bearings and shafting details.

3.   Dimensioning and tolerances

The dimensioning of drawings from centre and reference lines, machined and datum surfaces.

Limits and fits; clearance, transition and interference fits.
The method of indicating tolerances for selected ISO fits using hole basis. Candidates should be able to read and apply Data Sheet 4500A, which will be provided if required.

Geometrical tolerances to BS EN ISO 1101 covering straightness, flatness, roundness, cylindricity, profile of a line, profile of a surface, parallelism, squareness, angularity, position, concentricity, symmetry, runout and total runout. Material conditions are excluded.

4.   Symbols

Machine and surface texture symbols to BS EN ISO 1302.
Welding symbols to BS EN 22553.
Types of welded joints: butt, fillet, edge and lap.

5.   Freehand sketches

Freehand sketching to extend knowledge and appreciation of :
  a) screw fasteners and screw threads;
  b) locking devices;
  c) keys, keyways and splines;
  d) shaft couplings;
  e) bearings;
  f) pistons, connecting rods and crankshafts;

g) hole preparations: countersinks, counterbores and spotfaces.

The Computer-Aided Draughting (CAD) portfolio

1.   **General Guidelines**

a) CAD is an obligatory component. It carries 15% of the global mark.

b) The CAD component is continually assessed by the class tutor responsible for the subject.

c) Computer draughting assignments based on AutoCAD$^®$ up to 2D level will be covered during the 2 years duration of the course.

d) A portfolio shall be compiled by each candidate, and will contain hard copies (A3 size) of the assignments set by MATSEC and their computer generated solutions done by the candidate in class at fixed dates and times set by the MATSEC Board.

e) The candidates' portfolio with solutions marked by the tutor will be kept under strict confidential cover.

f) The three CAD assignments set by MATSEC shall be graded examples that progress with the knowledge gained both in the application of computer software and subject matter.

g) A tutor's sample copy of a model CAD portfolio is available on request from the MATSEC Board. This copy folio contains selected examples of practical assignments and solutions indicating the standard to be reached in the computer aided draughting component of the course.

2.   **Aims and Objectives**

The course is aimed at providing course participants with the fundamentals of Computer-Aided Draughting (CAD) using AutoCAD$^®$ software packages to draw 2D plans and/or 2D projections. This course requires the candidate to:

a) demonstrate competency in using some of the standard available features of a CAD application;
b) to create and manipulate objects or elements and to modify objects or elements;
c) be able to change object properties;
d) be able to present a drawing in the orthographic and isometric systems of drawing;
e) undertake printing or plotting activity in colour/monochrome with specific scales.

3.   CAD Content

Test 1 places emphasis on correct coordinate input, precise length and orientation of entities, efficient methods and practices. The exercise will cover the following topics and AutoCAD® commands:

3.1.1   Open and close AutoCAD® application. Only one drawing will be required to be open at any given time.
3.1.2   Create a new drawing. The system variable STARTUP should be set to 1. Candidate should be able to start a new drawing using the standard metric template acadiso.dwt.
3.1.3   Set model environment i.e. units, limits etc.
3.1.4   Set interface settings e.g. snap, grid, ortho
3.1.5   Use zooming tools
3.1.6   Panning a drawing
3.1.7   Understand & use Absolute and Relative Cartesian coordinate systems
3.1.8   Drawing commands as Line, Circle, Arc
3.1.9   Draw rectangle, polygon, ellipse
3.1.10 Hatch a closed entity to represent sections
3.1.11 Use snapping tools for accuracy
3.1.12 Erase & oops
3.1.13 Copy and Move objects
3.1.14 Apply Chamfers and Fillets
3.1.15 Trim operation
3.1.16 Create and set text styles, using only default options.
3.1.17 Select plotter/ printer
3.1.18 Plot all, part of drawing to a given scale from model space using `Awindow@` and `Acentre plot@`.

Test 2 places emphasis on the options available for the various drawing and editing commands that result in increased speed without loss of accuracy. The more advanced features of tracking, dynamic input, etc. are covered. The exercise will cover the topics and AutoCAD® commands listed below. Test 2 also assumes the content listed for Test 1.

3.2.1   Open multiple drawings and switch between them.
3.2.2   Create and save an AutoCAD® drawing template
3.2.3   Create named views & recall them
3.2.4   Understand & use Absolute and Relative Cartesian and Polar coordinate systems
3.2.5   The Pline and Spline drawing commands
3.2.6   The Rotate, Scale, Stretch, Extend & Offset modifying commands including pre-command editing
3.2.7   Mirror and array
3.2.8   Edit polylines and spline: decurve, fit, thickness, join & explode
3.2.9   Break and Explode operations
3.2.10 Create layers and assign properties as lineweights, line types, colour

3.2.11   Set a layer current
3.2.12   Modify status: On, Off, Freeze, Thaw, Lock, Unlock
3.2.13   Modify layer attributes
3.2.14   Create and set text styles with different fonts using all options.
3.2.15   Understand the difference between mtext and text commands
3.2.16   Set a text style current
3.2.17   Understand the text alignment abbreviations e.g. TR, TC, TL etc.
3.2.18 Create & set dimension style according to ISO Standard
3.2.19   Set a dimension style current
3.2.20   Create an override within a dimension style
3.2.21   Plot all, part of drawing from model space using all options

Test 3 places emphasis on layouts (paperspace) of orthographic drawings that include dimensions and other annotations. Draughting and the writing of text in isometric mode are also covered. The exercise will cover the topics listed below. Test 3 also assumes the content listed for Test 2.

3.3.1   Changing to isometric mode
3.3.2   Switching (toggle) between isoplanes (top, right & left views)
3.3.3   Isometric ellipses
3.3.4   Isometric fillets
3.3.5   Writing (text) in isometric mode
3.3.6   Understand difference between Model and Paper space
3.3.7   Add a new title block
3.3.8   Create viewports with different scales
3.3.9   Plotting using all options, especially printing from layouts

Practical Exercises

The three CAD assignments set by MATSEC and answered by candidates during the tests will be progressively stored on a CD which will be kept under confidential cover. Candidates will only have access to this CD during the fixed date and time of the CAD assignments set by the MATSEC Board.

Reading list

Eanna O Broin   **Technical Draughtmanship**   ISBN: 9780717116522
Colin H Simmons et al   **Manual of Engineering Drawing**   ISBN: 9780080966526
Edward Jackson   **Advanced Level Technical Drawing**   ISBN: 9780582355255
Francis X Dalli   **Graphical Statics**   ISBN: 9789995702311
Paul Green   **The Geometrical Tolerance Desk Reference**   ISBN: 9780750668217