Course Proposal Form

Please see Page 2 for instructions on which parts of this form to complete, whom to consult with to avoid unnecessary effort, and where to send the completed form.

Proposer(s): Kartic Subr **Date: Updated 11/03/2019 ~~08/03/2019~~**

Cover page: Basic permanent course information

Unless otherwise noted, items in this section are entered into EUCLID and **cannot** be changed without creating an entirely new course.

Course Name	Computer Graphics
Course Acronym *(used by the School only, e.g., for the Sortable Course List)*	CG
Course Level If the course is **only** available to MSc students, then it must be classed as Postgraduate. All other courses, regardless of level, are Undergraduate.	__Undergraduate X Postgraduate
Normal Year Taken	__UG1 __UG2 __UG3 X UG4 __UG5 __MSc
Also available in years *[This can be changed later if need be.]*	__UG1 __UG2 X UG3 __UG4 X UG5 X MSc
SCQF Credit Level Level 8 should normally be used for pre-honours courses. Level 10 should normally be used for optional UG3 courses (so UG4 students may also take them) and for courses aimed mainly at UG4 students. Level 11 should be used for courses aimed mainly at MSc students, whether or not UG4 students can also take them.	__7 __8 __9 __10 X 11
SCQF Credit Points	X 10 __20 __40 __60 __80 __Other:
Delivery Location	X Campus __On-line Distance Learning
Course Type	X Standard (default) __Dissertation __Online Distance Learning __Other (specify: Placement, Student Led Individually Created Course, Year Abroad)
Marking Scheme By default, courses use a numerical marking scheme. If you wish to use a grade-only marking scheme, your course proposal below should justify this.	X Standard (numerical) __Letter grade only

Guidance for remaining sections:

For an initial course proposal, please complete the **cover page and Section 1 (Case for Support)**, which asks you to describe the need for this course and to provide an overview of the course design, including the learning outcomes. **Please discuss your plans as early as possible with the head of Curriculum Review to avoid unnecessary effort.**

Send the form with these sections completed to the BoS Academic Secretary and head of Curriculum Review (listed on the BoS page) to obtain their comments before filling out the remainder of the form.

If a full proposal is invited, please complete the remaining sections and send to **iss-bos@inf.ed.ac.uk**.

2. Student-facing course description and additional feedback and assessment information.
This section provides most of the information students see in the DRPS entry for this course, as well as related details for BoS consideration.

3. Further information for BoS consideration: sample materials.

4. Additional Course Details required for DRPS. *[Administrative information such as delivery timing and prerequisites.]*

5. Placement in degree programme tables. *[Required for all level 9-11 courses; used to determine where the course will be added to existing degree programme tables.]*

6. Comments from colleagues. *[All course proposal should be sent to relevant colleagues in the area as well as to the appropriate year organizer and BoS Academic Secretary for comment in good time before the BoS meeting. Use this section to indicate what feedback has been solicited and received.]*

Colour coding and item-by-item guidance:

Guidance is provided in italics for each item. Please also refer to the guidance for new course proposals at http://www.inf.ed.ac.uk/student-services/committees/board-of-studies/course-proposal-guidelines. Examples of previous course proposal submissions are available on the past meetings page http://web.inf.ed.ac.uk/infweb/admin/committees/bos/meetings-directory but note that the proposal form was updated in Jan 2019.

Sections in gold are for student view and are required before a course can be entered into DRPS. You must complete these sections even if your course has already been approved based on other documentation.
Sections in orange are for School use but are still required for all courses (even those that have already been approved based on other documentation).
Section in gray are for consideration by the Board of Studies. They are normally required for all new course proposals but may be omitted in some circumstances (e.g., for invited course proposals) if you obtain permission in advance.

1. Case for support

This section is for consideration by the Board of Studies. The final two boxes (Learning Outcomes, Graduate Attributes) will also go into the student-facing course description.

Overall contribution to teaching portfolio and relation to existing curriculum

Please explain (a) what motivates the course proposal (e.g. a previous course having become outdated/inappropriate, an emergent or maturing research area or new research activity in the School, offerings of our competitors) and (b) how it relates to existing courses and degree programmes (including any prerequisite courses). Every new course should make an important contribution to the delivery of our Degree Programmes.

CONTEXT

Like many areas of applied Computer Science, advancements in Computer Graphics research steadily appear in popular (open-source) libraries and tools. Further, the field has expanded so much that what used to be a 'session' at SIGGRAPH (the primary conference in the field) now has an entire (respectable) conference dedicated to the topic.

CURRENT COURSE

The current course (taught by Kartic Subr and Hakan Bilen in 2017-18) takes a bottom-up approach, introducing students to fundamental concepts in graphics (particularly rendering) such as line drawing algorithms, modelling of curves, geometric transformations, etc. However, given the current state of the field, this approach is no longer feasible (especially for 10 credits). It is justifiable that students would feel 'cheated' in that they leave the course with no real knowledge about state-of-the-art systems. On the other hand, teaching new developments in CG at high-level concepts without a sound foundation has its share of problems. The current course also has a final exam, which restricts the evaluation of learning outcomes to toy problems and no programming. While the core topics in CG require proficiency in linear algebra and probabilistic methods, the ability to design and build programs that use libraries which provide abstractions for these methods is vital. Unfortunately, the current course attaches a very small weightage to programming, since a bulk of the evaluation is via a final exam.

UPDATED COURSE

The updated course will cover the main topics in CG at a high level (e.g. modelling, rendering, animation, sound, display, HCI, computational photography) but delve into depth on one of these topics. i.e. rendering. Rendering has two major components – real-time rendering and physically based (high quality) rendering. Each of these would potentially require a 10-point course to explore the topic in depth. To tackle this problem, rather than to propose a 20-point course, the revised course will be designed to explore them individually in alternating offerings. This would make it attractive (and sensible) for a student to take two consecutive offerings of the CG course without redundant learning. This is a suggestion, and I am happy to consider other possibilities. However, what I would like to ensure is that the course gets a significant revamp to match student expectations as well as demand from industry, while still focussing on academically fundamental concepts.

INDUSTRY

Rendering is the cornerstone of the digital creative process and therefore has a profound impact on the creative industry. It is central to many applications including video games, cinematic special effects, advertising, medicine, etc. A significant portion of the special effects industry is now based in and around London. These companies are struggling to find British students equipped with the skills required.

The updated course will focus on rendering techniques.

Target audience and expected demand

Describe the type of student the course would appeal to in terms of background, level of ability, and interests, and the expected class size for the course based on anticipated demand. A good justification would include some evidence, e.g. by referring to projects in an area, class sizes in similar courses, employer demand for the skills taught in the course, etc

The CG course has attracted 54 students in its last offering. In my interaction with the students, I realised that they were very excited to learn about the latest developments in the field but were disappointed that the course did not lead up to the state of the art.

Anticipated Resource Requirements

Estimate how much lecturing, tutoring, exam preparation and marking effort will be needed in steady state, and any additional resources needed to set the course up initially. Provide estimates relative to class size where applicable and discuss how support staff will be recruited and supervised, if the class is likely to be very large. Please mention any scaling limits due to equipment or space. If equipment is required, say how it will be procured and maintained.]

70h TA
2 Tutors (depending on numbers)
+60h TA (for first offering only)

Quotas, special arrangements or unusual characteristics

Please specify if this course requires any special arrangements such as quotas or other registration arrangements; is a collaboration with another school or institution, or has other atypical characteristics that may affect finances or student registration. Further justification/information may be requested for such courses.

Narrative description of the course aims and structure

Please describe the main goals of the course and how the course design will allow students to achieve those goals. This section should be consistent with the student-facing information provided below, but should provide additional information to help colleagues at BoS understand the vision and structure of the course. This description may refer to the learning outcomes and graduate attributes (next two boxes) and should explain how activities such as tutorials, labs, or in-lecture activities will support them, and how the proposed assessments will assess them.

For courses that are important pre-requisites for other courses, this section may also provide content/syllabus information which is too detailed for the student-facing description, such as a lecture-by-lecture syllabus.

--- Course structure ---
2 lecture hours per week
1 tutorial hour per week
2 summative assignments
1 formative assignment
No final exam

(3 summative assignments will be provided, and the best two marks for each student will contribute to final grade).

Summary of Intended Learning Outcomes (MAXIMUM OF 5)

List the learning outcomes of the course. These must be assessable (i.e., observable), so must specify what the student should be able to do concretely, not simply what they should "understand". Use concrete verbs that indicate (a) what type of assessment would be appropriate, and (b) what level of knowledge/thinking is expected (from recall to analysis to novel creation). ***Example verbs:*** *define, explain, implement, compare, justify. Assessments (described later) should be tied to the learning outcomes.*

Outcomes should typically focus more on the types of thinking/skills developed than on the detailed course content, and the level of thinking should be appropriate to the level of the course: outcomes for a Level 11 course should include more higher-level thinking skills than for a Level 8 course. Further guidance on writing learning outcomes can be found at https://www.ncl.ac.uk/ltds/assets/documents/res-writinglearningoutcomes.pdf

On completion of this course, the student will be able to

1) Define different sub-topics of Computer Graphics and to identify the focus of each of these areas. The student will also be able to describe the key open (and imminent) problems in each focus area.

2) Explain the difference between real-time rendering systems (used in the video game industry) and physically-based rendering (used in cinematic and medical applications).

3) Predict performance and output of state-of-the-art rendering libraries and tools for different classes of input models.

4) Design and develop programs to solve specific rendering problems by exploiting features of state-of-the-art rendering libraries.

5) Interpret the results of standard algorithms on their respective failure cases, and suggest alternatives.

Graduate Attributes, Personal & Professional Skills

List the personal attributes and generic transferrable skills this course will help develop. Examples include

Cognitive skills: *problem-solving, critical/analytical thinking, handling ambiguity*

Responsibility, autonomy, effectiveness: *independent learning, self-awareness and reflection, creativity, decision-making, leadership, organization and time management, flexibility and change management, ethical/social/professional awareness and responsibility, entrepreneurship*

Communication: *interpersonal/teamwork skills, verbal and/or written communication, cross-cultural or cross-disciplinary communication*

- Practical skills: understanding and using open-source libraries to solve problems, application of theoretical concepts to solve novel practical problems.
- Cognitive skills: problem-solving, analytical thinking
- Responsibility, autonomy and effectiveness: independent learning, creativity and time-management.

2. Student-facing course description and additional feedback and assessment information

Except where noted, all fields are required and will go into the DRPS entry for the course (for use by students). Important: any text in DRPS is effectively a contract with students, so should not include details that are likely to change from year to year.

Summary Description *Provide a brief official description of the course, around 100 words. This should be worded in a student-friendly way, it is the part of the descriptor a student is most likely to read. If this course replaces another course, please say so in this summary.*	This introductory course in computer graphics comprises of three parts. The first part of the course presents a bird's-eye view of the current state-of-the-art in the field. The latter two parts cover rendering, which is one of the core topics in computer graphics, in detail. The second part of the course teaches central concepts in rendering, along with the relevant mathematics. Finally, the third part of the course focusses on applications of the theory taught in the second part.
Keywords *Give a list of searchable keywords.*	Rendering, Real-time, Monte Carlo Image Synthesis, Raytracing, Light transport, Rasterization
Course Description *A more detailed student-facing description of the course, which should normally include (a) a more in-depth academic description of the learning aims, nature and context of the course, (b) a rough outline of the content or syllabus, often as bullet points, and (c) a description of how the course will be taught, how students are expected to engage with their learning and how they will be expected to evidence and demonstrate their achievement of the intended learning outcomes.]*	SYLLABUS Part I • Introduction [1] • Radiometry and photometry [1] • Modelling [1] • Special effects I: relighting [1] • Special effects II: compositing [1] Part II • Raytracing [1] • The rendering equation [2] • Monte Carlo path tracing [2] • Sampling [2] • Camera effects [1] Part III • Participating media [1] • Acceleration structures [1] • MCMC methods for light transport [1] • Gradient domain path tracing [1] • Overview of current research [1/2] • Discussion of open problems in rendering [1/2] • Conclusion [1]
Assessment Weightings: *These should correspond approximately to the proportion of learning outcomes that each component assesses. More than 30% coursework requires specific justification.* *The expectation for a 10pt course is 20% coursework with the equivalent of one 15-20hr assessed assignment (but possibly split into smaller pieces). See 'components of assessment' below.*	Written Exam ___0__% Practical Exam __0___% (*for courses with programming exams)* Coursework _100__%

Further Assessment Information *Provide any further information that should go on DRPS for students. E.g., if the assessment includes required group work or if students must pass some individual component of assessment as well as the course overall.*	There will be 3 coursework submissions, one associated with each part of the course, and all three will be marked. For each student, the best two marks (of the three) will contribute to the final grade.
Components of assessment and time spent on assignments (for BoS only) *If not already included in the course narrative description, please describe the type of assessments (oral presentation, report, programming, etc) and **how each component of assessment will assess the intended learning outcomes**. Where coursework involves group work, it is important to remember that every student has to be assessed individually for their contribution to any jointly produced piece of work.* *Also estimate **how many hours** students will spend on assignments. Please see the School policy on Workload and Assessment, which states that students should not be expected to spend more than 6-7 hrs/wk per 10 credits, including contact hours.* *Note that it often desirable to include formative assignments which are not formally assessed but submitted for feedback, often in combination with peer assessment.*	All three coursework submissions will involve programming. These assignments will reinforce the theoretical concepts taught in class, for each part, as well as demonstrate the practical implications of the theory. The problems for the first two coursework will be identical for all students. The third coursework will involve a creative component, which will allow each student some flexibility to explore their individual interests, albeit within the framework of the course. Each coursework is expected to take 8-9h, with one due every three weeks. So the workload for coursework is expected to be at most 3h/wk. Lectures are 2h/wk and 1 tutorial h/wk = total workload of 6h/wk. In practice, since one of the assignments is formative (implicitly), the estimated workload is an upper bound.
Feedback Information *Provide a high-level description of how and what type of feedback will be provided to students, for inclusion in DRPS.*	The main feedback in this course will be along with the marking for each of the coursework (3 in total). Interactive feedback can be requested during office hours (of the instructor as well as TA). In addition, public or private queries will be answered on a Piazza page associated with the course. Any confusion, misunderstanding or mistakes that seem to be common (for each assignment) will be discussed in the tutorial hour following the marking of that assignment.

Additional Feedback Information (for BoS use only)

If not already included in the course narrative, provide further details on planned feedback arrangements. This includes how course feedback is solicited from the class and responded to, as well as what feedback students will get (either on work that contributes to their final mark, or not).

The University is committed to a baseline of principles regarding feedback that we have to implement at every level, and the School encourages submission of at least one piece of written work for formative feedback.

In general, formative feedback:

- *Should say how students can improve.*
- *Need not be on individual work (e.g., consider a lecture or document summarizing common issues.)*
- *Can include oral feedback during labs/tutorials*
- *Can include feedback from peers*
- *Clickers/TopHat/equivalents can provide in-class feedback for both students and lecturer.*
- *Is returned in time for other forms of assessment to which it relates, to allow feedforward.*

Breakdown of Learning and Teaching Activities

State how many hours students spend on each part of the course. The total should be 10 x course credits, but please also see the School policy on Workload and Assessment.which states that students should not be expected to spend more than 6-7 hrs/wk per 10 credits, including contact hours.

Assume 10 weeks of lectures slots and 10 weeks of tutorials, but these need not all be used. As a guideline, a 10-pt course typically has 18-20 lecture hours, but should have only around 15 lectures of examinable material; the rest should be used for guest lectures, revision sessions, introductions to assignments, etc.

Contact hours

Hours	Type
19	Lecture Hours
8	Seminar/Tutorial Hours
	Dissertation Project Supervision Hours
	Supervised practical/Workshop/Studio hours
	Feedback/Feedforward hours
	Summative assessment hours
	Revision Session Hours

Non-contact hours

Hours	Type
73	Directed Learning & Independent Learning hours

Total hours: 100

Reading List/Learning Resources

You are encouraged to create resource lists using LEGANTO

TBD

3. Further information for BoS consideration: sample materials

A full proposal for a new course must include examples of exercises and assessment. Please provide these below, along with publicity information if the course is to be advertised outwith the School.

Course information and publicity *The course web page (typically the Learn landing page) will be linked from the Sortable Course List, and information such as timetables and assignment deadlines must be made available prior to the start of the academic year. Please specify here if any additional info/publicity is needed for your course: typically only if it is aimed largely at non-SoI students.*	
Sample tutorial/lab sheet questions *Provide a list of tutorial questions and answers and/or samples of lab sheets. These need not be fully fleshed out but should indicate what sort of exercises will be provided to help students learn the material.*	The tutorials will cover practical aspects of the taught concepts. Typically, these will involve programming and usage of open-source libraries that implement state-of-the-art algorithms. e.g. see https://www.inf.ed.ac.uk/teaching/courses/cg/index2017.html#Tutorials
Sample assessment materials *If the course is primarily assessed by **exam**, provide a sample exam question with model answers. Any non-standard exam format must be justified. The online list of past exam papers gives an idea of typical and alternative exam formats: http://www.inf.ed.ac.uk/teaching/exam_papers/.* *If the course is largely or primarily assessed by **coursework**, provide a sketch of a possible assignment with an estimate of effort against each sub-task and a description of marking criteria.*	The assignments will be similar to previous assignments, but more challenging in light of the greater contribution of each assignment to the final grade (from 15% to 50%). https://www.inf.ed.ac.uk/teaching/courses/cg/index2017.html#Assignments
Any other relevant materials *Include anything else that is relevant, possibly in the form of links. If you do not want to specify a set of concrete readings for the official course descriptor, please list examples here.*	

4. Additional Course Details for DRPS

Except where otherwise noted, these fields are required for entry into EUCLID and will be visible to students in the DRPS entry.

Planned Academic Year of Delivery *(The first year you anticipate the course running, e.g. AY 2019-20)*	2019-20
Course Organiser *(By default, the course proposer)*	Kartic Subr
Intended Delivery Period	_X_ Semester1 __ Semester 2 __ Full Year __ Summer __ Other (please specify):
Timetable considerations/conflicts *For School use. Please specify any constraints to be considered (e.g. overlap of popular combinations, other specialism courses, external courses etc). Include whether the semester delivery is constrained or could be flexible.*	
Is this course available to visiting students?	_X_ Yes (default) __ No **If no, please provide a justification here:**
Required pre-requisite courses *Use sparingly: these are enforced in PATH and can only be waived by approval from the School's Curriculum Approval Officer. Note that cross-year required pre-requisites may prevent MSc students from registering; consider using recommended pre-requisites or "other requirements" instead.*	__X__ No _ Yes (please specify full course name(s) and code(s)):
Recommended pre-requisite courses	_X_ No __ Yes (please specify full course name(s) and code(s)):
Required co-requisite courses *Specify any courses that must be taken in parallel with the existing course. Note that this leads to a timetabling constraint that should be mentioned elsewhere in the proposal.*	_X_ No __ Yes (please specify full course name(s) and code(s)):
Prohibited Combinations *Specify any courses that may not be taken in combination with the proposed course].*	_X No __ Yes (please specify full course name(s) and code(s)):

Other Requirements/Additional Information *This information is often used by MSc students and students from other Schools to see if they have appropriate background without having done our School's courses. So please avoid course titles, instead list specific knowledge and skills (such as mathematical concepts, programming ability or specific languages, etc).* *Also list any other constraints on registration, for example: "Only available to 4th Year Informatics students including those on joint degrees." or "This course is open to all Informatics students including those on joint degrees, and to students in the School of Mathematics. Other external students whose DPT does not list this course should seek permission from the course organiser."*	_No _X_Yes (please specify): A relevant programming course (suggestions from BoS welcome here.) The rendering libraries used in the course are written in C++. Some provide Python interfaces.
Visiting Student Pre-requisites	_X Same as "other requirements" __Different than "other requirements" (please specify): Visiting students are required to have comparable background to that assumed by the course prerequisites listed in the Degree Regulations & Programmes of Study. If in doubt, consult the instructor. The rendering libraries used in the course are written in C++. Some provide Python interfaces.

5. Placement in degree programme tables: for level 9-11 courses only

This section is for consideration by the Board of Studies and will be used later by ITO to determine where the course will be added to existing degree programme tables.

Is this course restricted to students on a specific degree? *E.g., some courses are only available to students on a specific CDT or MSc.*	X No __Yes (please specify and provide justification):
Is this course compulsory for students on any degree(s)?	X No __Yes (please specify and provide justification):
Any issues for part-time students? *Normally, part-time students have access to the same courses as full-time students on the equivalent degree. If you anticipate any problems with this, please specify here.*	As long as the students are familiar and willing to cope with the expected workload, no.

For optional courses:
If this course is available but non-compulsory for students on various degrees (most courses), please fill in this section. The choices here determine where the course appears in degree programme tables (DPTs) and the 2-3 character tags are displayed in the Informatics sortable course list.

Should this course be tagged as 'ML' (machine learning foundations and methods)? *Courses with the ML tag are typically very high-demand and most degrees limit the number of ML credits. If your course might appeal to a similar audience but draw off students from these large courses, please select 'no' and choose one of the tags below.*	X No __Yes
If you chose 'no', please choose at least one of the following tags… *Ideally, select exactly one, unless there is a good argument for more than one. These three are used in various combinations for many of our degrees.*	X **FSS** (CS foundations, systems, and software) __**AIA** (artificial intelligence applications and paradigms) __**COG** (cognitive science: including HCI and NLP courses, but not most other AI courses. Please restrict to courses most relevant to natural cognition.)
…and also tick if any of the following tags or categories apply. *Do not tick any of these if you selected 'ML' already.*	__**NS** (natural systems: e.g., computation by or about biological or social systems. Many COG courses are also NS. This tag is mainly relevant for MSc in Informatics.) X **SE** (software engineering: including courses that are highly relevant to SE degrees. All SE courses should also be FSS. This tag is mainly relevant for UG SE degrees.) __Databases and data management systems (used for Data Science MSc and MSc(R)) __Unstructured data and applications (used for Data Science MSc and MSc(R)) __Level 11 Security courses (used for Security MSc)

If you are not sure which tags are most appropriate or have other questions about this section, please note any comments/issues here.	

6. Comments from colleagues

All course proposal should be sent to relevant colleagues in the area as well as to the appropriate year organizer and BoS Academic Secretary for comment in good time before the BoS meeting. Please indicate here what feedback has been solicited and received.

Additional Comments *Summarise any comments received from relevant individuals prior to proposing the course. If you have not discussed this proposal with others please note this.*	I have discussed several possibilities for the course with Sharon Goldwater and Taku Komura. Several combinations and possibilities were considered, and I have tried to combine them into this proposal.
Year Organiser Comments *Year Organisers are responsible for maintaining the official Year Guides for every year of study, which, among other things, provide guidance on available course choices and specialist areas. The Year Organisers of all years for which the course will be offered should be consulted on the appropriateness and relevance on the course. Issues to consider here include balance of course offerings across semesters, subject areas, and credit levels, timetabling implications, fit into the administrative structures used in delivering that year.]*	
BoS Academic Secretary Comments *Proposals must be checked by the Secretary of the Board of Studies prior to discussion at the actual Board meeting. This is a placeholder for their comments, mainly on the formal quality of the content provided above.*	